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KEY TO PROJECT SERIES/SLEUTEL TOT PROJEKTEREEKS

DIRECTORATES/DIREKTORATE

BM	:	Biometric and Datametric Services	Biometriese en Datametriese Dienste
LI	:	Agricultural Engineering	Landbou-ingenieurswese
PE	:	Agricultural Production Economics	Landbouproduksie-ekonomie

RESEARCH INSTITUTES/NAVORSINGSINSTITUTE

GB	:	Soil and Irrigation	Grond en Besproeiing
GG	:	Grain Crops	Graangewasse
GS*	:	Vegetable and Ornamental Plants	Groente en Sierplante
OP	:	Veterinary Science (Onderstepoort)	Veeartsenykunde (Onderstepoort)
PB	:	Plant Protection	Plantbeskerming
PL	:	Botany	Plantkunde
SS	:	Citrus and Subtropical Fruit	Sitrus en Subtropiese Vrugte
TK	:	Tobacco and Cotton	Tabak en Katoen
VS	:	Animal and Dairy Science	Vee- en Suiwelkunde
VV	:	Fruit and Fruit Technology	Vrugte en Vrugtetegnologie
WW	:	Viticulture and Oenology	Wingerdbou en Wynkunde

REGIONS/STREKE

H	:	Highveld	Hoëveld
K	:	Karoo	Karoo
N	:	Natal	Natal
D	:	Eastern Cape (Dohne)	Oos-Kaap (Dohne)
T	:	Transvaal	Transvaal
V	:	Free State	Vrystaat
W	:	Winter Rainfall	Winterreën

*Summaries of final reports as well as running facets still appear under the code TB
Opsommings van finale verslae asook lopende fasette verskyn nog onder die kode TB

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Note: The Department issues a separate list of research workers and lecturing staff, which is obtainable on request from the Directorate of Agricultural Information, Private Bag X144, Pretoria 0001. Information in this edition covers the era 1986.04.01 – 1987.03.31.

Let wel: Die Departement reik 'n aparte lys uit van navorsers en doserende personeel, wat op aanvraag verkrygbaar is van die Direktooraat Landbou-inligting, Privaatsak X144, Pretoria 0001. Inligting in hierdie uitgawe dek die tydperk 1986.04.01 – 1987.03.31.

FINAL REPORTS ON RESEARCH PROJECTS
FINALE VERSLAE OOR NAVORSINGSPROJEKTE

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REPORTS (SUMMARISED)

PLANT PRODUCTION PROMOTION

AGRONOMY RESEARCH

Summer grain

MAIZE

- *Nutrition*

GG.2111/05/3/1: A GREEN-HOUSE TECHNIQUE DEVELOPMENT FOR THE ACCURATE APPLICATION AND CONTROL OF ALL THE ESSENTIAL NUTRIENT ELEMENTS FOR MAIZE. 1983
F.G. Adriaanse

A special technique whereby the concentrations and ratios of the different forms of nutrients could be accurately applied and regulated was successfully developed. This greenhouse-technique consisted of six hydroponic systems with 70 asbestos pots for each system. Quartz sand was used as a growth medium and the pots were watered with nutrient solutions by sub-irrigation.

In addition the technique has been used by Mr T.C. van Eeden for his M.Sc. studies and its use is still in demand.

MAIZE

- *Crop science*

GG.2111/30/3/13: PHYSICAL CHARACTERISTICS OF COMPACTABLE MAIZE PRODUCING SANDY SOILS. 1983-1984
J.A.G. Henning

The results seem to indicate that the relation between cone penetration resistance and bulk density of sand is influenced by the degree of sorting. Poor sorting results in a lower cone penetration resistance at selected bulk densities than moderate sorting.

Maximum compaction as obtained with the Standard Proctor method, for each soil study, depended upon water content. Each soil sample is characterised by a specific optimum water content at which maximum compaction occurred. Thus water content increased with an increase in clay content. The optimum water content at which the different soils compacted to optimum bulk densities were also influenced by the compaction effort. Optimum water content decreased with compaction effort. Maximum bulk density increased with an increase in compaction effort.

The water content, clay content and sorting of sandy soils should be considered when current concepts regarding the compaction effort of individual tillage implements, are evaluated.

Other agronomy crops

COTTON

- *Nutrition*

TK.2141/05/1/4: REACTION OF COTTON TO K: Ca: B RATIOS IN POT EXPERIMENTS. 1983-1984
N.J.J. Combrink

It was observed in a field trial at the Loskop Research Station that high levels of potassium (K)

reduced cotton yields. A pot experiment with two levels of K, Ca and boron (B) was conducted. This 2x2x2 factorial experiment was replicated eight times and carried out in a greenhouse.

It could be demonstrated that high levels of K application suppressed yield only when low Ca levels prevailed. This interaction was due to the significant reduction of Ca uptake by plants at the high K level.

Three different physiological leaf abnormalities were observed:

(i) *Transparent spots on leaves*

These symptoms became visible when leaves were held against the sun, when a group of enlarged cells with little or no chloroplasts between the two epidermal layers became apparent. This was most prominent at low Ca and B levels.

(ii) *Necrotic lesions*

These symptoms can easily be wrongly identified as the advanced symptoms of *Xanthomonas malvacearum*. The first step in the development of a lesion seems to be the breakdown or damage of cell walls in the spongy parenchyma, or in the phloem of the veins of the leaf blade. As in the case of the transparent spots, the lesions were most severe at the low Ca and B levels.

(iii) *Cupping of young leaves*

The affected leaves usually had yellowish edges and the leaf tips could become necrotic. It occurred at the low Ca level and was aggravated by the high K level.

The effect of high levels of K which can do serious damage to cotton at a low Ca level, should be established under field conditions as a guide-line for K and Ca fertilisation.

COTTON

• *Pests*

TK.2141/20/1/1: CONTROL OF NEMATODES IN COTTON. 1982-1986
R.J. van Wyk

Research to combat nematodes in cotton by means of nematocides was not very successful. A heterogeneous nematode distribution on farms, contamination by means of flood irrigation and too little available irrigation water hampered the research.

Preliminary results show an increase of cotton yield from 2-6 ton/ha when 25 l/ha EDB or Nemacurr was used. The research will be continued at Kroondal under controlled circumstances.

TOBACCO

• *Nutrition*

TK.2142/05/1/8: DETERMINATION OF LIME REQUIREMENT FOR TOBACCO SOILS.
1983-1985
E.A. Davies

In the past tobacco production has been confined to the black turf and red clay soils, the pH of which are generally in the region of 5, 6-8,8. However, recently production has been extended over areas which include acid sandy soil types. The pH of these soils may be as low as 4,0. At these low pH levels the fertility of the soil is limited by (1) impoverished nutrient status and (2) the presence of toxic substances. It has been recognised that in order to overcome the deleterious effects of acid on plant growth, lime should be applied. However, the controversy still exists concerning the criteria on which predictions of lime requirements should be based. At the Tobacco and Cotton Research Institute lime recommendations have been based on the pH of the soil, applications being made to any soil with a pH lower than 5,8.

This situation was investigated by means of four pot experiments and one field trial. The results of the first pot experiment, whereby tobacco was grown at different pH levels on 3 different soil types, show conclusively that this is an inaccurate basis on which to make lime recommendations.

Results of a second pot experiment where tobacco on five different soils was grown over a pH range from 4-8.0 revealed that pH had no significant effect on yield.

However, at lower liming levels, undesirable mottling and distortion of leaves occurred. These symptoms disappeared once the soil calcium level had been raised to 300 ppm. It is proposed that poor yields on acid sandy soils of low Al content are due to an impoverished nutrient status rather than to an excessive H ion concentration. Hence liming should aim to raise the calcium content of the soil to 300 ppm.

Earlier maturation and senescence were observed in plants of low calcium and potassium content, and sandy acid top soil (pH 4) was used in the third glasshouse pot experiment to study the influence of calcium and potassium on the rate of senescence, yield and value of flue-cured tobacco leaves. Four rates of Ca [as $\text{Ca}(\text{OH})_2$] and four rates of K (as KCl) were applied to the soil and arranged factorially in a blockless design. Tobacco leaves which had yellowed on the plant were reaped after 67, 75 and 86 days growth, and flue-cured.

The highest level of Ca delayed senescence while too early senescence occurred at the lowest Ca level. The highest yield was obtained at the third Ca level, (2.0 me/100g) while the highest Ca level gave no further significant increase in yield. The tobacco of highest value was also that grown at the third Ca level. The highest Ca level brought about a decrease in value. A Ca content in leaves as high as 3.2% was associated with the decrease in value observed at the fourth Ca level.

The level of K interacted with Ca in its influence on the rate of senescence. The highest K level maximised yield and value. A high K content of the cured product was associated with high value.

And finally a study was made of the influence of Ca:K ratios and B levels on the chlorophyll content of excised leaf discs before and after subjection to an artificial water stress.

Tobacco and cotton plants were grown in Mitscherlich pots, under glasshouse conditions, and supplied with nutrient solution. Three Ca:K ratios and two levels of B were applied in a factorial experiment which was arranged in a completely random design.

Leaf discs were excised from different levels of the plant and at different stages during the growth period. Artificial water stress was created by floating the discs on a solution of polyethylene glycol 6000 at an osmotic potential of -1 800 kPa.

The level of B nutrition was found to interact significantly in determining the loss of chlorophyll at different Ca:K ratios.

TOBACCO

• Upgrading

TK.2142/07/1/10:

A CYTOGENETIC STUDY OF THE *NICOTIANA TABACUM* X *N. RUSTICA* HYBRID. 1981-1984

A. van der Spoel

The following information was gathered from an embryogenetic study of the two species *Nicotiana tabacum*, *N. rustica* and their reciprocal crossings.

Self-pollination leads to normal seed production. No fertilisation occurs when *N. tabacum* is used as the mother parent in the above-mentioned cross. Degeneration of the undeveloped embryo sac can be seen at different stages. In the reciprocal cross, development occurs to a certain extent, but a single normal seed may only develop in rare cases.

Double fertilisation occurs whenever development takes place and both the embryo and endosperm start to develop. Fertilisation is somewhat restricted in the interspecific crosses and fewer ovums are fertilised.

The hybrid embryo develops normally or near to normal until the young seed is destroyed, which may occur any day after pollination. The endosperm develops abnormally from about the fifth or sixth day after pollination.

The endosperm of the self-pollinated *N. rustica* varieties form cells with big vacuoles. The endosperm of the hybrid divides slower and becomes smaller and more compact as development takes place.

In normal development, the nucellus contains one layer of thin cells, but in the hybrid the nucellus becomes active and forms more layers. The elastic nucellus may completely enclose the endosperm owing to the chalaza opening being completely overgrown.

Even a small opening in the nucellus between the endosperm and the integument, making contact between these two possible, can bring about a marked increase in the life expectancy of the ovum. A few seed may even reach maturity in this manner.

In self-pollination, the vascular bundle stretches about half way between the funiculus to the chalaza pocket, and the opening, is filled within a day or two after fertilisation by differentially elongated integument cells. This differentiation does not occur in the crosses, even if the ovum lives up to 10 days after pollination.

The nucellus and integument of the hybrid seeds are filled with starch before aborting, concluding that a shortage of nutrients is not responsible for this degeneration. The final degeneration of the seed begins with the decomposition of the endosperm, beginning in the chalaza and spreading to the embryo. Hyperplasia of the nucellus precedes the disintegration of the endosperm.

The degeneration of the hybrid seed is then primarily the result of limited development of the endosperm. The influence on fertility is indirect because secondary changes in other parts of the seed are also involved.

The degeneration is thus the cause of the degeneration of the endosperm due to hyperplasia of the nucellus and the limited changes, initiate the basis for the starvation of the endosperm and the enclosed embryo. This starvation is due to incorrect distribution rather than a lack of nutrients.

The degeneration of seed in crosses as discussed is the same as that in *Medicago sativa* after strick inbreeding. In singular cases, a few seeds may be formed. We thus have to do with incomplete somatoplastic sterility.

However, the embryo is not the cause of the sterility, rather degeneration owing to insufficient food availability. These embryos can thus be saved by *in vitro* embryo culture of fertilised ovums. In all cases a cut must be made in the ovum to ensure that there is an opening in the nucellus through which a direct supply of nutrients to the endosperm and embryo can take place.

In this manner the sterility which exists in the reciprocal *N. tabacum* x *N. rustica* cross, can at least in the case where *N. rustica* is the mother, be bridged. The advantageous characteristics carried by *N. rustica* can in this manner be used in *N. tabacum*.

TOBACCO

• Pathology

TK.2142/19/1/6:

INVOLVEMENT OF *FUSARIUM* WITH THE BLACK SHANK COMPLEX OF TOBACCO. 1983-1985

M.C. Engelbrecht

The tobacco wilt disease, caused by *Fusarium oxysporum* Schl. var. *nicotianae* John. has not been a problem in South Africa since the late 1960s. However, certain *Fusarium* species are isolated regularly from black shank diseased plants together with *Phytophthora nicotianae* var. *nicotianae*. The species were identified by the Medical Research Institute as *Fusarium oxysporum* and *Fusarium solani*. Pathogenicity tests were conducted on the wilt susceptible tobacco cultivars Joiner, Groot Swazi, and Coker 316. *Meloidogyne incognita* root knot nematode was included in certain treatments. Although penetration of *Fusarium* did occur, the isolates were not pathogenic.

A number of experiments were conducted to determine the possibility of an interaction between the *Fusarium* species and *Phytophthora*. Where *Fusarium* (concentration $5,68 \times 10^7$ spores/plant) and *Phytophthora* (concentration $1,6 \times 10^6$ zoospores/plant) were inoculated together, *Fusarium* could be reisolated as high as 8 cm above the black shank lesion in the woody tissue. It was only possible to reisolate *Phytophthora* from the pith and wood just above the lesion. Both organisms could be isolated from the lesion itself.

To determine the speed of penetration, *F. oxysporum* ($3,39 \times 10^7$ spores/plant) and *P. nicotianae* var. *nicotianae* were inoculated on plants 4 weeks after *M. incognita* (4 200 larvae/plant). *F. oxysporum* could be reisolated from the roots and crown 2 days after plant inoculation. *P. nicotianae* var. *nicotianae* could only be reisolated from these parts 5 days after inoculation. Similar results were obtained in a trial with *F. solani*.

F. oxysporum could also be reisolated 2 days after plant inoculation when *M. incognita* was not present, while *P. nicotianae* var. *nicotianae* could only be reisolated after this period in the presence of the nematode. However, the speed or intensity of black shank development, as determined in another factorial experiment with *M. incognita* (4 500 larvae/plant), *F. oxysporum* ($1,4 \times 10^8$ spores/plant) and *P. nicotianae* var. *nicotianae* ($5,76 \times 10^6$ zoospores/plant), was in no way altered by the presence of *F. oxysporum*.

It is concluded that, although *F. oxysporum* and *F. solani* can penetrate so rapidly and be isolated so high above the lesion, they play no predisposing role in the black shank complex. The isolates are either avirulent, weakly pathogenic or only secondary.

• *Pests*

TK.2142 20 1 1:

BIOLOGY AND CONTROL OF INSECTS IN STORED TOBACCO:
CHEMICAL CONTROL OF THE CIGARETTE BEETLE, *LASIODERMA*
SERRICORNE, IN TOBACCO WAREHOUSES. 1969-1986

E.G. Eulitz

In this study it was found that the rate of development of cigarette beetles, feeding on ground tobacco, were lower than that of cigarette beetles feeding on maize meal containing 5 % of brewer's yeast.

Cigarette beetles developed faster in rearing medium (maize meal plus 5 % brewer's yeast) with a high moisture content (15 %) than in rearing medium with a low moisture content (10 %). The rate of development of cigarette beetles increased from 25 to 35 °C while no development was observed at 40 °C.

Two groups of cigarette beetles reared separately on ground tobacco and maize meal containing 5 % of brewer's yeast, did not differ in their susceptibility to tetrachlorvinphos 50 % wettable powder or bromocyclen 50 % wettable powder. Surveys at a tobacco co-operation showed that sanitation must be regarded as an important cigarette beetle control measure.

In light traps fluorescent blacklight attracted approximately twice the number of cigarette beetles than ordinary tungsten globes.

Investigation of the possible use of reconditioning plants in a cigarette beetle control programme showed that the older types of reconditioning plants, with an operating cycle of 22 to 75 minutes would kill all stages of the cigarette beetle, if the maximum temperature exceeds 77 °C.

A dosage of 250 kilorad was necessary to kill all stages of the cigarette beetle within 72 hours while dosages of 25 to 50 kilorad gave almost total sterility.

The use of ultra-low volume application of pyrethrins can reduce oil residues and cut the cost of the treatment without loss of efficiency.

Effective cigarette beetle control was obtained with ultra-low volume dichlorvos treatment at dosages of 14,1 to 28,3 ml/1 000 m³.

The registered dosage for vacuum fumigation with ethylene oxide (150 g/m³ for 2 hours) did not give effective cigarette beetle control whereas aluminium phosphide applied at a dosage of 5 pellets/m³ killed all the experimental insects inside tobacco bales, fermentation stacks and in the free air space.

Bromocyclen 50 % wettable powder, tetrachlorvinphos 24 % emulsifiable concentrate and tetrachlorvinphos 50 % wettable powder, respectively had a residual action of one week, one month and three to six months. Carbaryl 30 % colloidal suspension was found to be ineffective.

Ultra-low volume application of pyrethrins and dichlorvos may cut the cost of cigarette beetle control measures whereas phosphate fumigation is considerably cheaper than vacuum fumigation with ethylene oxide.

Ultra-low volume treatments with permethrin at 9,3 g permethrin/1 000 m³ controls beetles in the free air space when applied at regular intervals.

In comparative tests tetrachlorvinphos at 1,0 g active ingredient (a.i.)/m², deltamethrin wettable powder and flowable at 0,31 g a.i./m², cypermethrin emulsifiable concentrate at 1,0 g a.i./m², cypermethrin wettable powder at 0,5 g a.i./m² and fenvalerate wettable powder at 0,5 g a.i./m², controlled cigarette beetles for 12 months on hessian, glass, PVC plastic, zinc, wood, brick, PVA paint on cement, distemper on cement and cement panels.

Dichlorphos (70 %) emulsifiable concentrate (Nuvan 7) applied as a ultra-low treatment did not disperse evenly in the free air space of a small room with a volume of 147,9 m³ if only one point of application was used.

Dichlorphos in CO₂ in a pressurised cylinder applied as a ultra-low volume treatment at 9,0 and 18,0 g dichlorphos/1 000 m³ gave effective control of beetles in free air space.

TOBACCO

• *Pests*

TK.2142/20/1/3:

INVESTIGATION OF CERTAIN TOBACCO PESTS AND THEIR
CONTROL. 1973-1985

E.G. Eulitz

The control of bollworm, false wireworm and aphids was investigated by means of field, laboratory and

glasshouse experiments. The control of cutworm and crickets was investigated by means of field experiments only. The phytotoxicity of insecticides and certain weedicides was investigated by means of field and glasshouse experiments. Finally the efficacy of certain crop sprayers was compared.

Carbofuran 10% granular at 2 g product per running metre applied immediately after planting controlled bollworm and reduced damage for up to 10 weeks. Acephate granular and aldicarb granular did not control bollworm in the field. Acephate 75% water-soluble powder (wsp) at 1 kg product 500 l water/ha gave good control of bollworm and regular spraying at 14 day intervals gave adequate protection. *Bacillus thuringiensis* within seven days after application gave inferior control of bollworm compared to acephate, monocrotophos sprays and carbaryl dust.

The residual effect of different insecticides against bollworm during accelerating growth of tobacco plants in the glasshouse, is as follows: acephate wsp 7 d, metomil wsp 2 d, monocrotophos ws-liq 4 d, endosulfan wettable powder (wp) 4 d, carbaryl wp 2-4 d, profenofos ec 4 d, permethrin wp 4 d, cypermethrin 50/50 cis/trans 4 d and cypermethrin high cis 4 days.

Chlorpyrifos 48% ec at 2 ml product/l water drenched as 30 ml mixture per plant gave the best protection to tobacco transplants against damage by false wireworm (*Tenebrionidae*, *Mesomorphus* spp). Chlorpyrifos ec sprayed, phoxim gran, phoraat gran, cypermethrin ec drenched, chlorfenvinphos ec sprayed and chlormephos gran treatments reduced damage by false wireworm but are significantly less effective than the chlorpyrifos drench treatment. Diazinon wp gave good mortality of false wireworm larvae in damp soil but when the soil was dried in the sun it became ineffective.

The cutworm and cricket experiments did not produce results because the expected damage to the tobacco plants did not materialise.

Damage to tobacco owing to phytotoxicity was shown to be the result of overdose, and poor application, e.g. heaping of dusting powders over the apex of the plant which is aggravated if the leaves are wetted before or after application. The use of insecticides not registered for tobacco can also result in damage e.g. gamma BHC.

A weedicide containing nitratin which is registered for use on tobacco at transplanting, could be phytotoxic when applied on tobacco later than 6 days after transplanting. In this instance the wrong time of application was the reason for the phytotoxicity.

A mistblower and a swathgun were found to be unsuitable for insecticide application on tobacco. The swathgun particularly gave very uneven spray distribution.

TOBACCO

• Pests

TK.2142/20/1/4: CHEMICAL CONTROL OF APHIDS ON TOBACCO. 1980-1986.
E.G. Eulitz

The experiments were done to compare a new 5% granular formulation of acephate and carbofuran 10% granular as used for bollworm control, with acephate 75% water-soluble powder (wsp) and aldicarb 15% granular. The last two insecticides are registered for aphid control on tobacco.

The experiments were carried out in a glasshouse at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Individual tobacco plants were grown in 7.5 l asbestos cement pots. Each plant was fertilised with 5 g of limestone ammoniumnitrate (28% N) and 18 g of a compound (6% N:9% P:12% K) at 2 and 7 days, respectively, after transplanting. The plants were watered as required.

Infestation of the plants with aphids (*Myzus persicae*), from a colony, took place two and three weeks after transplanting. The plants were allowed to grow to a height of approximately 30 cm., about four weeks after transplanting, before the insecticides were applied. The dosage to be applied to the pots for soil treatments was calculated as 25% of the field dosage. In all experiments the acephate 75% wsp was applied as a single spray at 2 g/l sprayed at an equivalent of 500 l mixture/ha. Reinfestation of the plants after treatment with the insecticides occurred by natural dispersal of aphids from the untreated control plants which were highly infested throughout the experiments.

The aphid infestation per plant was rated as follows:

5. + 2 501 aphids per plant
4. 501-2 500 aphids per plant

3. 11-500 aphids per plant
2. 1-10 aphids per plant
1. No aphids per plant.

TOBACCO

• Crop science

TK.2142/30/1/5:

SPACING, TOPPING AND FERTILISING OF ORIENTAL TOBACCO.
1977-1985

M.P. Lamprecht and W.J.C. van der Merwe

The influence of spacing, topping and fertilising on Oriental tobacco was investigated at the Experimental Station at Elsenburg, Stellenbosch.

Plants of the Elcatra and Soulouk Oriental tobacco (*Nicotiana tabacum* L.) cultivars were spaced 75 x 20 cm, 50/25 x 10 cm and 50/25 x 20 cm. In the 50/25 cm spacing, twin rows, 25 cm apart, were followed by a 50 cm interrow space. The 10 cm and 20 cm spaced plants were topped to 14 and 28 leaves, respectively. The different treatments were laid down in a randomised block experiment with three replications in 1974/75, 1975/76 and 1976/77.

The 50/25 x 10 cm spaced plants were double the normal plant population and produced the highest yield, income, total alkaloid and nitrogen concentrations. This result was not considerably influenced by cultivar or seasonal differences. The substantial increase in income per hectare must, however, be considered against the increased expenditure associated with a doubled plant population and leaf number per hectare.

From 1977 to 1980 three levels of nitrogenous fertiliser were applied to Oriental tobacco (*Nicotiana tabacum* L. cv. Elcatra) at different spacings and topped to 14 and 28 leaves per plant, respectively. Yield, income, total nitrogen and total alkaloids of the cured leaves increased, and total reducing sugars decreased as nitrogen application was increased. Acceptable levels of quality attributes such as total nitrogen, alkaloids, and reducing sugars, as well as a high income, were obtained when plants were spaced 20 cm from each other in 25 cm twin rows with an interrow space of 50 cm, topped to 28 leaves and fertilised with a high level of N (72 kg N ha⁻¹).

TOBACCO

• Chemistry

TK.2142/53/3/1:

PESTICIDAL AND PLANT GROWTH REGULATORY RESIDUES ON
TOBACCO: THE DISSIPATION OF INSECTICIDAL RESIDUES ON
TOBACCO, 1969-1986

E.G. Eulitz

Remedies for the control of tobacco pests and diseases were investigated by spraying and dusting in the field and treatment of tobacco in warehouses. Using residue analyses and taste tests the acceptability were determined.

Owing to these tests D.D.T., Birlane (chlorfenvinphos), methylbromide + chloropicrin (for tobacco bales and stacks) and carbaryl + molasses were found to be unacceptable.

The following remedies were found acceptable and were released for use on tobacco; monocrotophos, phosphamidon, bromocyclene, pyrethrins + piperonyl butoxide, mercaptothion, dimethoate, endosulfan, methomyl, carbaryl, tetrachlorvinphos (on bales and in warehouses), acephate, chlorpyrifos, aldicarb, permethrin u.l.v. (in warehouses), and methylbromide + chloropicrin (for soil fumigation).

The following remedies, for which residues were determined, are cypermethrin 60:40 isomer ratio, cypermethrin 50:50 isomer ratio, fenvalerate, propanocarb hydrochloride, profenofos and fenthioate.

HORTICULTURE RESEARCH

Tuber crops

POTATOES

- *Pathology*

TB.2411/19/1/3: THE CHEMICAL CONTROL OF FUSARIUM DRY ROT OF POTATOES.
1980-1985
B.W. Young

Of the fungicides tested *in vitro* for effectiveness as post-harvest protective treatment of potato tubers against dry rot, thiabendazole (TBZ) was the most effective.

Possible explanations for occasional reports of lack of control of dry rot by the chemical were also sought. It was found that TBZ was fungistatic only, even at concentrations of 100 p.p.m. It is applied in the sorting shed and handling of tubers after sorting implies loss of fungicide from the tuber surface and therefore loss of inhibitory effect on fungal growth. It has also been recently established in studies on tuber dry rot that other *Fusarium* species, apart from *F. solani*, can cause dry rot in tubers and TBZ does not have the same effect on all species.

Two other common tuber diseases, anthracnose and silver scurf, were also investigated. The fungus causing the latter disease was inhibited fairly adequately by TBZ in the *in vitro* tests and some control of anthracnose was obtained by a mixture of fungicides.

Because of the increasing incidence of these tuber diseases in crops, they will be examined in separate facets in more concentrated studies than was possible in this facet.

POTATOES

- *Pests*

TB.2411/20/1/3: MIGRATORY HABITS OF POTATO VIRUS VECTORS IN TRANSVAAL
REGION. 1976-1984
D.C.A. Hoffman

The original aim of this facet was to develop a virus-vector forecasting system for seed producers. Data, compiled over a period of five years, showed that there is a definite period of low vector activity. The period of low vector activity, as well as the intensity of the main migratory flights, varied among seasons and localities. Coupled to these differences among localities, the high cost of a monitoring action does not make it practical to implement a comprehensive forecasting system as originally proposed.

Because seed growers only manage to produce certifiable seed with varying success and with the aid of intensive (and sometimes excessive) chemical control programmes, it was decided to alter the aim of this facet to the production of good quality seed with maximum yield by optimal utilisation of the period of low vector activity.

Trials were conducted over three seasons at three registered seed growers in fields planted for certification. Aphid migration flights were monitored. Samples were collected daily from the suction trap used and weekly from the yellow traps and examined at Roodeplaat. Seven periods of haulm destruction, replicated five times, were applied towards the end of the growing season at weekly intervals. After harvest the yield of each size class was determined. Samples from each treatment were planted in performance trials in the Eastern Lowveld and the percentage infection of leaf roll and mosaic were visually determined. The virus infection was compared with the migration flights to determine if there was any correlation between virus and vector incidence.

It was found that:

1. Because of high production costs, it is essential to obtain optimal yields.

- Most crops are planted under dry-land conditions so moisture conservation before planting is important.

- Seed potato crops must be planted as early in the season as possible.
 - Only well-sprouted tubers should be planted.
 - As high nitrogen and potassium levels prolong the growing season, these should be kept as low as practically feasible.
 - Tuber bulking must progress as far as possible before the main migration peaks begin.
2. The presence of virus-infected potato plants in the immediate vicinity of the seed fields is a critical factor in the virus pressure.
- Maximum isolation must be maintained from infection sources.
 - Volunteer potato plants should preferably be destroyed by cultural means or suitable herbicide.
 - Crops intended for the table market should be sprayed for aphid control for the entire growing season.
3. The successful utilisation of the period of low vector activity guarantees the production of seed with a low virus content.
- Aphid migration be monitored daily with the aid of a suction trap.
 - Taking into account factors such as isolation distance, virus pressure and yield at that time, haulm destruction should be carried out at the start of the second migration peak or when a drastic increase in the number of *Myzus persicae* is detected.
4. To ensure that occasional virus-infected aphids do not colonise seed potato plantings, crops must be subjected to a chemical control programme throughout the growing season.

Vegetables

LEGUME VEGETABLES

• Pathology

TB.2425/19/1/1: LEGUME VEGETABLES: A STUDY OF HALO BLIGHT OF GREEN BEANS. 1975-1985
B.H. Boelema

The purpose of the facet was to develop a method to evaluate green bean cultivars and breeding lines in the glasshouse for resistance to halo blight. The first step was to obtain information on suitable inoculum doses. The results of this work were published in the article: Boelema, B.H., 1984. Infectivity titrations with race 2 of *Pseudomonas syringae* pv. *phaseolicola* in green beans (*Phaseolus vulgaris*). *Phytophylactica* 16, 327-329.

Following this study several cultivars were tested. The results were published in the Research Note: Boelema, B.H., 1985. A glasshouse test for screening green bean cultivars for resistance to halo blight caused by *Pseudomonas syringae* pv. *phaseolicola*. *Phytophylactica* 17, 99-100.

Results of further work on the resistance of breeding lines have been reported under TB.2425/30/1/1: Legume vegetables: evaluation of green bean cultivars and breeding lines.

Some of the results of the infectivity titrations were included in an article on dose/response relationships: Boelema, B.H., 1985. Dose-response relationships between phytopathogenic bacteria and their hosts. *Netherlands' Journal of Plant Pathology* 91, 189-202.

Flowers and ornamental plants

PROTEAS

• Pests

TB.2431/20/1/1: STUDY AND CONTROL OF PESTS IN PROTEAS. 1981-1984
J.H. Coetzee

Winter-flowering *Protea repens* (L.) L. is the host for 91 phytophagous insect species. Insects feeding

on the plant can be divided into three groups, namely seed-head feeders, leaf feeders and flower visitors. A study was made of the eight main borers that feed in the seed-head to ascertain whether there is competition for food in the seed-head. Competition was investigated with regard to niche overlap, the co-occurrence co-efficient index (species packing), the competition co-efficient and the availability of food. Since positive evidence was found that competitive exclusion actually takes place, the adjustments that occur to relieve competitive pressure in the seed-head were investigated. The division of the seed-head into different feeding spaces and the utilisation of the seed-head at different times of the year, are regarded as the main evolutionary adjustments. Thirty-two leaf feeders were found; most of the damage to the leaves was caused by leaf miners. Forty-five species gathered in the open inflorescence, and they fed mainly on pollen and nectar.

The second phase of this study dealt with the effect which the insects have on the plant. More than 80 % of the seed reserve which is stored on the plant, is destroyed by insects during the first two years after blossoming. Leaf feeders are responsible for the destruction of over 10 % of the total leaf surface. Field experiments proved that the insects that visit the inflorescence act as pollinating vectors. Seed-setting does not increase if birds are also allowed to reach the flowers.

CUT FLOWERS

• Chemical control

TB.2433/21/1/2: CUT FLOWERS: CHEMICAL CONTROL TECHNIQUES FOR SCARABAEIDAE ON ROSES. 1973-1985
J.M. Donaldson

The biology of beetles belonging to the Cetoniinae and Rutelinae was known only in general terms. No studies had been made of the life cycles of any of the commonest species that attack roses. Very few larvae and pupae could be found in the field and those that were collected could not be identified until they had been reared to adults. Therefore, efforts were concentrated on developing rearing techniques for these beetles and studying their life cycles in the laboratory.

The results of these studies in combination with observations made on larvae in compost heaps were used to draw up recommendations for the management of beetle populations that were pests on fruit and roses, particularly in home gardens. Chemical control of the larval stages of Rutelinae in soil or Cetoniinae in compost heaps was impractical and thus control had to be aimed at the adults.

Considerable success had been achieved in America on reducing damage by the Japanese beetle to various crops by trapping beetles using chemical compounds as lures. The Japanese beetle is a rutelid and closely related with similar habits to local Rutelinae and Cetoniinae. Thus it was possible to use many of the techniques developed by the Americans here with modifications for local conditions.

Candidate compounds for testing as lures were mainly obtained from the USDA. There was only a short trapping period of 6-8 weeks each year, when beetles occurred in sufficient numbers for trapping so it took several years before real achievements were attained. An efficient general lure for both Cetoniinae and Rutelinae was identified, as well as a species-specific lure for a cetoniid species and another for the commonest rutelid, *Anomala transvaalensis*, which is a pest of grape vine and rose leaves.

A beetle trap was developed in co-operation with an agricultural chemical organisation, which markets the trap with a general lure for Cetoniinae and Rutelinae throughout South Africa. Feedback indicates that the lure performs very satisfactory for the rose-chafer, *A. transvaalensis* and other related species. However, a species-specific lure is still needed for the fruit beetle, *Pachnoda sinuata flaviventris*.

CUT FLOWERS

• Integrated control

TB.2433/23/1/1: CUT FLOWERS: INTEGRATED CONTROL OF MITES ON CRYSANthemUMS. 1981-1984
M.C. Bolton

The effect of the predator mite *Phytoseiulus persimilis* on *Tetranychus urticae* populations on

chrysanthemums was studied in a commercial glasshouse. The aim of this study was to determine the feasibility of integrated pest control in glasshouses.

It was found that a gradient of 2,6 °C in temperature and 5 % in relative humidity did not influence the effectiveness of *P. persimilis*. All areas in the glasshouse were therefore favourable for population increases of the predator mite.

Experimental results also proved the efficiency of *P. persimilis* as a control agent of *T. urticae* on chrysanthemums in a glasshouse.

Since February 1983 the American leaf miner *Liriomyza trifolii* has become the most important pest of chrysanthemums in glasshouses. This pest demands intensive chemical control measures and therefore the study on biological control of mites was discontinued.

Pome and stone fruits

APPLES

• Physiology

VV.2441/03/3/1: MECHANISM OF ACTION OF TRIADIMEFON IN IMPROVING FRUIT SET OF STARKING DELICIOUS. 1982-1985

L. Gouws

Five repeat spray applications at 10 days before full bloom (FB), at full bloom through petal fall (PF), till PF + 20 days of 50 and 100 mg/litre active ingredient (a.i.) triadimefon were made on 25-year-old Starking Delicious trees. Similar repeat applications at 14 days before FB and weekly thereafter till PF + 10 days of 50, 100 and 150 mg/litre a.i. triadimefon were made on 7-year-old 'Delicious' trees. Treatment resulted in a reduction in the second fruit drop, increase in fruit set and yield without affecting fruit size. Similar applications to flowers or spur leaves with or without blossom thinning were done on 7-year-old 'Delicious' trees. Treatment of any combination of the terminal and lateral flowers gave a poorer set than when all flowers in a cluster were treated. Fruit set per cluster did not differ when triadimefon was applied to only the spur leaves or all flowers in a cluster or both. Triadimefon reduced the surface area of petals, ovary diameter and pedicel length whereas pedicel and ovary dry mass increased. Triadimefon significantly increased the retention of unpollinated flowers.

Spray applications of triadimefon (1-4 chlorophenoxy-3,3 dimethyl 1-1-H-1,2,4 triazol 1-yl-2 butanone, 5 % wp) at 100 mg.l⁻¹ a.i. at 14 and 7 days before full bloom on 7-year-old Starking Delicious trees increased the number of seeds per fruit. Triadimefon reduced the number of seedless fruit while increasing the proportion of fruit with high seed counts. Triadimefon altered the distribution of seeds in the 5 loculi of individual fruit which had four to seven seeds and increased the number of loculi containing two seeds. Style removal reduced fruit set to the same extent in treated and control flowers.

During this study methods were developed for the extraction, purification and quantification of the plant growth regulators IAA, ABA cytokinin and GA. The methods included the use of physical-chemical extraction procedures and quantification by bio-test or gaschromatography/HPLC.

APPLES

• Crop science

VV.2441/30/1/3: HORTICULTURAL COMPARISON OF 30 STARKING-TYPE APPLES. 1978-1986

P.R. Jolly

Early Red One was the only full-red cultivar out of 30 to be released from this facet and was published in Information Bulletin No. 543 in 1984.

Since release, bud sales of Early Red One (44 000) compare very favourably with that of Starking (15 300), Red Chief (19 800) and Topred (209 600) over a two-year period.

Evaluation of Groth Red and Starking F Strain will continue in the facet VV.2441/30/1/2: Second

phase evaluation of apple cultivars and selections; since the young Groth Red trees planted in the Langkloof and Ceres areas are not yet in bearing and Starking F Strain must still be virus-free before further evaluation can take place.

Seven cultivars already in the apple industry were included in the thirty cultivars under evaluation for comparison.

Out of the remaining twenty cultivars, the five - Idared, July Red, Macspur A, Macspur B and Morspur - are not Starking types and because of very poor colour, are not acceptable to the industry.

The other 15 Starking types are also not acceptable to the industry because of either very poor colour or poor bearing ability.

The Elgin Experimental Farm trees grew very well, while most of the trees at the Langkloof Experimental Farm suffered from wet feet and many died. There were visible tree size differences between standard trees and spur-bearing trees, e.g. Early Red One 24,2 cm and Wellspur 16,5 cm trunk circumference in the 7th year.

Approval for the release to the industry of Early Red One and termination of evaluation of the other cultivars was given by the Work Group for the Evaluation of Dessert Fruit.

APPLES

• *Crop science*

VV.2441/30/6/1: EVALUATION OF GRASS AND LEGUMES AS COVER CROPS IN APPLE ORCHARDS OF THE WESTERN CAPE. 1983-1986
W.A.G. Kotzé

The performance of various grass and legumes and their suitability as cover crops in deciduous fruit orchards were tested in a small plot trial at Stellenbosch and in existing orchards in Ceres, Robertson and Villiersdorp.

Seeding date and harvest date were important factors which determined total dry matter produced and total nitrogen content of especially snail medic, Clare subterranean clover and serradella was markedly affected. Of the 62 crops assessed at Stellenbosch 23 performed with exceptional vigour. These included two annual medics (Harbinger and snail), six subterranean clovers (Clare, Mount Barker, Nungarin, Seaton Park, Woogenellup and Yarloop), four lupins (Jak, Steb, Stevens and Neuland), four vetches (Common, Benghalensis, Grazing and Purple), serradella and two trefoils (*Lotus hispidus* and *L. sabbiflorus*).

In an orchard in Robertson best growth was obtained from two subterranean clovers (Woogenellup and Mount Barker) which were efficient annual self-seeders, two clovers (Assegai and Huia white clover) and a cover of mixed vetches (Hairy, Purple and Common). The relative persistence of the perennials sainfoin, white clover and red clover was also apparent. In soils with lower pH values serradella was an efficient self-seeder.

At Villiersdorp the cover crops which performed best were the perennials Haifa white clover, strawberry clover and companion grass.

As a group the subterranean clovers grew well in winter, reseeded themselves efficiently, did not compete for bee pollination and died down in summer and thus did not compete with the tree for water and nutrients during its active growing season. Furthermore, they are low growing and provide an abundant mulch.

Future research will be aimed at the proper management of cover crops in order to obtain maximum advantage from them without undue competition with the fruit trees.

PEARS

• *Pathology*

VV.2442/19/1/1: CONTROL OF CALYX-END ROT IN PEARS. 1983-1986
J.C. Combrink

Packham's Triumph pears in two production areas (Vyeboom and Stellenbosch) were treated with fungicides during two consecutive seasons (1983/84 and 1984/85) to develop control measures against

calyx-end rot caused by *Botrytis cinerea*. Single applications of fungicides were applied from full-bloom until 7 weeks thereafter. Multiple procymidone sprays were applied to trees in the same orchards to determine whether more than one application is required for effective control. Time of application ranged from full-bloom to 7 weeks later and the number of applications from one to three.

Fruit were stored at $-0,5^{\circ}\text{C}$ for 5 months before evaluation. To predict the extent of calyx-end rot, air samples were taken in orchards to estimate the number of *Botrytis cinerea* colony-forming units (CFU) in orchard air, the extent of colonisation of flower parts and the relationship between colonisation and calyx-end rot was assessed, and the number of *B. cinerea* CFU/pear was determined during the last month before harvest. The effect of cooling rate and method of packing was also determined.

The incidence of calyx-end rot was low during both seasons but fungicides were nevertheless effective. Single applications of benzimidazole (benomyl, thiabendazole) or dicarboximide (iprodione, procymidone or vinchlozolin) fungicides, applied after 75 % petal fall, decreased the incidence of calyx-end rot significantly. Results obtained with analyses of air samples drawn in pear orchards were inconsistent. Blossoms were colonised by fungi at full-bloom and the extent of colonisation increased until about one month before harvest, whereafter it remained relatively constant but calyx-end rot was not related to colonisation. Few *B. cinerea* CFU were present on the surfaces of pear fruit.

It was therefore impossible to predict whether or not calyx-end rot will develop by monitoring fruit for the presence of the fungus. Cooling rate and packing method had no effect on the development of calyx-end rot. It is recommended that a single application of a registered fungicide is applied to pears towards the end of blossoming to control calyx-end rot.

Viticulture

WINE GRAPES

- *Anatomy*

WW.2462/02/1/2: ANATOMY AND ULTRASTRUCTURE OF THE LEAF OF WINE AND OTHER GRAPE TYPES. 1985
C.E. de Villiers

The aim of this study was to create a standard reference source for the leaves of different phytosanitary healthy cultivars so that anatomical anomalies caused by some or other abnormal phenomenon may be identified, as well as to make the identification of closely related cultivars easier and to study the effects of different factors on the anatomy of the leaf.

Seven cultivars were examined under the light microscope in order to determine their qualitative leaf characteristics in the middle of the growth season and on three positions on the shoot, namely apical, middle and basal. This study gives a clear picture of how the tissues and cell contents of healthy leaves appear and how the leaf structure changes with age. In future, abnormalities on the basis of qualitative characteristics can be easily identified. Since the characteristics of the different cultivars are so similar and the variation within cultivars is greater than between cultivars, qualitative characteristics cannot be used to identify closely related cultivars. The value of this work, therefore, lies in the ease with which the seat of anatomical abnormalities of the vine leaf can be identified in future. Since the aims of this facet have already been fulfilled, its termination is now recommended.

WINE GRAPES

- *Anatomy*

WW.2462/02/1/3: REVIEW OF THE ANATOMY OF WINE GRAPES. 1982-1985
A.C. de la Harpe

To make a complete review of all available literature on the anatomy of wine grapes so that a source document can be established to satisfy the literature requirements of all anatomical research planned at the Viticultural and Oenological Research Institute (VORI).

A complete review of 132 typed pages using 255 references was compiled initially. From this work resulted a publication: "The anatomy of the genus *Vitis*: an annotated bibliography" in the *South African Journal of Enology and Viticulture* 3(2), supplement.

WINE GRAPES

- *Crop science*

WW.2462/30/1/2: EFFECT OF METHOD AND TIME OF PRUNING ON PHENOLOGY AND PERFORMANCE OF WINE GRAPES: CHENIN BLANC. 1979-1985
J.J. Swanepoel

The effect of 4 pruning systems, viz short bearers, Cazenave, Guyot and a combination of long and short bearers on the yield and vegetative growth of Chenin blanc located at two localities above sea-level (60 m and 335 m), were investigated.

The aim of this study was to develop a pruning system by which fertility problems and low production of vineyards above a certain altitude (± 300 m) could be overcome without detrimental effects on shoot growth.

Although the shorter pruning systems (short bearers and Cazenave) resulted in better budding percentages, at both localities, the yield of these systems were lower than those obtained from the longer systems (Guyot and combined). The longer systems however, caused a decline in vegetative growth, especially at the lower altitudes where the growth was more vigorous. Therefore, to overcome the problem of low production at higher altitudes a combination of long (2 bearers per vine) and short bearers (5 per vine) is suggested, depending on the vegetative growth.

WINE GRAPES

- *Crop science*

WW.2462/30/6/4: RELATIVE PERFORMANCE OF ROOTSTOCK CULTIVARS FOR WINE GRAPES ON A HUTTON SOIL UNDER IRRIGATION: VAALHARTS. 1976-1985
W.F. van der Westhuizen

The aim of this study was to obtain the best adapted rootstock cultivar for wine grapes in the Vaalharts area.

This facet entailed a field experiment of 0,50 ha at Vaalharts Agricultural Research Station in which 7 rootstocks as well as an ungrafted control were evaluated for yield, growth and cluster characteristics.

After 8 years of data on yield and growth of 7 grafted rootstocks it was found that Ramsey is the best adapted rootstock for the Vaalharts region. The good performance of 99 Richter and 110 Richter is also noteworthy while it was shown that the practice of using ungrafted vines in this region can not be recommended any more. The good performance of Ramsey ($44 \text{ t} \cdot \text{ha}^{-1}$) is mainly because of the high resistance of this rootstock against nematodes. Definite rootstock recommendations for wine grapes in this region can now be made. In order of preference Ramsey, 99 Richter and 110 Richter must be used.

Oenology

WINE

- *Technology*

WW.2471/52/1/1: FACTORS THAT DETERMINE THE REPRODUCIBILITY OF AROMA FORMATION IN AND THE QUALITY OF WINE. 1981-1985
A.C. Houtman

In this study the factors that influence bouquet in white wines were studied and their effect on wine

quality evaluated so that they could be applied in wine making to consistently achieve high wine bouquet concentrations. Both laboratory and cellar studies were carried out on five grape cultivars and eight yeast strains.

Grape maturity influences the fusel alcohol and acetate ester formation in wine. Both fusel alcohols and the acetate esters i-amyl acetate and 2-phenyl ethyl acetate show a decrease in the wine with increasing grape maturity.

It has been found that must particulates affect ester formation in the wine. An increase in particulate matter in the must initially effects an ester increase in the wine up to a point. Subsequent increases in particulate matter causes ester decreases. Must particulates contain a fraction that had a marked effect on formation of volatile wine components and fermentation tempo. The filterability of this fraction differed between cultivars. Filtered Colombar and Chenin blanc juice showed retarded fermentation whereas Riesling and Muscat d'Alexandrie fermentations did not lag. Although seven of the eight yeast strains studied required this fraction for propagation and completion of fermentation, specific requirements between strains differed radically.

Sterile filtered juice was used as base of the investigation of factors which influence fermentation tempo and also to investigate means of reactivating lagging fermentations. Addition of settled juice was successfully applied in many cases to re-activate tardy fermentations. Lengthy and retarded fermentations could be effected by filtration or drastic clarification of musts. A satisfactory fermentation tempo could be achieved in such cases by addition of a mixture of ergosterol, unsaturated fatty acids and a readily assimilable nitrogen source.

Sterile filtered juice of five cultivars gave wines with practically identical acetate and ester concentrations in their wines. It was proposed that this be termed the basic fermentation bouquet of wine. A factor such as must particulates could modify these concentrations.

Fusel alcohol formation in wines increased as must particulate increased. A similar pattern is shown with increasing temperature. In clear filtered juice fusel alcohol formation is not affected by temperature. The formation of acetate esters of fusel alcohols increase drastically with addition of ergosterol to the filtered juice. An accelerated fermentation as effected by air, can also lead to an increased fusel alcohol concentration in the wine.

It was found that the lower esters occur chiefly in the wine whereas higher esters are mainly in the yeast cells.

Citrus and subtropical crops

CITRUS

- *Upgrading*

SS.2481/07/1/3:

THE PRODUCTION OF IMPROVED CITRUS TYPES BY MEANS OF
SHOOT-TIP GRAFTING AND TISSUE CULTURE. 1975-1985

J.H. de Lange

Shoot-tip grafting as a technique to eliminate virus diseases from citrus clones for the Citrus Improvement Scheme Shoot-tip grafting (STG), originally developed in the USA, was initiated in South Africa in 1975. Material from most of the best available trees of all locally important cultivars and selections has undergone STG.

These plants have been indexed as being free of viruses and many trees resulting from topworking of this material onto mature trees at Addo to test their trueness-to-type, have already borne fruit. Virus-free, true-to-type material are being released by the Department of Agriculture and Water Supply to the Foundation Block at Uitenhage where material is being multiplied and distributed to the industry by the SA Co-operative Citrus Exchange. After nucellar trees at Messina Experimental Farm have been evaluated, this material will also be included in the scheme.

Owing to the omnipresence of tristeza in South Africa, pre-immunisation of the virus-free material with mild strains is of utmost importance. Attention is being given to this aspect and especially to grapefruit which is severely affected by the stem-pitting component of tristeza.

CITRUS

• *Chemical control*

SS.2481/21/1/1: CHEMICAL WEED CONTROL IN CITRUS ORCHARDS. 1973-1983
A.P. Vincent

The experiment was done on Frost valencias with empress mandarin rootstock for the period 1973 to 1983. The following twelve treatments were applied, namely:

1. Control grass is cut
2. Cultivation control hand hoeing
3. Paraquat
4. Glyphosate
5. Bromacil
6. Prometryn
7. Diuron
8. Plastic mulching placed underground
9. Rotary hoe
10. Glyphosate plus diuron
11. Bromacil plus paraquat
12. Diuron plus paraquat

The chemical weed control like diuron plus glyphosate and diuron plus paraquat as with plastic mulching give higher production than bromacil and cultivation by hand or rotary hoe. The fibre strength of the fruit in weed-free plots was softer than those of fruit grown together with weeds. No significant differences were found in fruit quality and mineral composition of the leaves.

PINEAPPLES

• *Crop science*

SS.2482/30/1/2: CROP MANIPULATION IN PINEAPPLES. 1970-1986
D.B. Dalldorf

The use of flower inductants such as alpha naphthalene acetic acid (ANA), beta-Hydroxyethylhydrazine (BOH), ethephon (Ethrel) and ethylene gas were all investigated in respect of concentrations, volumes to be used, time of application and effect on plant characteristics. Very little information was available on its application under South African pineapple growing conditions. Fruit enlargers and fruit yellowers were not registered for use in South Africa or any other pineapple producing country when this investigation started and even less was known of their effect on pineapples.

The findings were that ethephon is most beneficially applied during the warmer period of the year (September to March) for flower initiation of the Smooth Cayenne plant crop in the Eastern Cape. This was mainly because of its greater effectiveness and improvement of fruit shape in comparison to ANA. At all other times ANA applications proved more desirable to the plant crop and subsequent ratoon crops.

In the warmer Hluhluwe and Levubu areas, indications are that ethephon was generally superior to ANA on Queens and Smooth Cayennes irrespective of crop or time of the year.

Fruit enlarger work with sodium 2-(2,4,5 Trichlorophenoxy propionic acid) or Fenoprop, and ANA was carried out using different concentrations and volumes, split applications, different times of application (physiological stages of the fruit), and various sites of application. After taking into account all considerations, Fruitone CPA is recommended at 2 to 4 litres per hectare, applied between 100% dead petal stage and approximately 6 weeks later. To prevent top burn damage it was found that applications directed onto the fruit yielded excellent results. Directing sprays only onto the leaves was also a successful way of preventing top burn. It also increased fruit mass, although not as much as when applying only on the fruit.

Fruit yellowing with ethephon was shown to be an excellent method of reducing fruit blemishes, caused by physiological problems, such as sunburn and Black Heart. It could also reduce the severity of Black Spot and Leathery Pocket. The loss in yield by applying ethephon at too early a stage was also demonstrated.

Based on the findings of this research it is recommended that 1 to 2 litres of commercial product, depending on time of year, should be applied when the sugar content of the fruit has reached a desired level.

AVOCADO

• Physiology

SS.2483/03/1/2: STOCK-SCION INTERACTIONS IN AVOCADOS. 1981-1985
J.P. Bower

Avocado stock-scion interactions were studied in terms of tree growth above and below the graft union, canopy size and biochemically through the effect on the peroxidase enzyme.

It was found that most of the combinations showed above to below graft stem circumference ratios close to 1, and that as far as the normally used stock-scion combinations were concerned, no horticultural incompatibility was evident.

The peroxidase isoenzyme study showed a marked effect of stock-scion interaction. The results obtained may go some way to explaining the apparent effect of scion on the root rot resistance of certain stocks. The existence of a scion altered the peroxidase banding pattern of the rootstock, which may alter tree characteristics.

Thus it was found that while stock-scion incompatibility was not marked, there was nevertheless a more subtle but possibly important interaction.

AVOCADO

• Physiology

SS.2483 03 1 3: PHYSIOLOGICAL ASPECTS OF DISEASE RESISTANCE IN AVOCADOS.
1973-1985
L.J. van Lelyveld

Phytophthora root rot caused by *Phytophthora cinnamomi* is a main problem affecting avocado trees in many countries. In the Republic of South Africa it appears that plantings vary in their extent of infection from 0 to 80 %. It has shown that certain cultivars and selections may be more tolerant to infection. It has been shown by other investigators that certain enzymes, such as peroxidase (PO) and indoleacetic acid oxidase (IAA) as well as certain phenols may play a role in the plant's tolerance to infection. It was, therefore the purpose of this investigation to establish whether some of these aspects may be applicable to the avocado and may be used as markers to identify tolerance in selection research.

Several phenolic acids were extracted and separated from newly matured avocado leaves. After hydrolyses they were identified as caffeic, sinapic, ferulic, p-coumaric and p-hydroxybenzoic acids. It was found that several of these phenols either inhibited or activated the enzyme indole-3-acetic acid.

The response of a number of enzymes to *Phytophthora* root rot was studied. Peroxidase (PO) activity decreased with increased severity of disease symptoms. The resistance of some avocado trees to root rot appears to be associated with the formation of new peroxidase isoenzymes. These new isoenzymes appear to exist in Duke and are induced in more resistant Fuerte trees. Proanthocyanidins extracted from avocado leaves were shown to act as inhibitors of peroxidase activity and may play some role in disease response. Root-stock and scion bark from healthy trees also have a higher PO activity compared to infected trees. Rough bark may be associated with either a weak graft union or with incompatibility and can be identified by a significant increase in PO enzyme activity in the rootstock or root bark.

The cultivar Duke 7, more resistant to root rot, showed the highest phenylalanine ammonia-lyase (PAL) and indoleacetic acid oxidase and the lowest polyphenol oxidase (PPO) activity compared to more susceptible cultivars.

Callus cultures were grown from Duke 7 cuttings and treated with phytotoxic extracts from *Phytophthora cinnamomi* cell walls and culture medium. Both these extracts induced the accumulation of fluorescent metabolites in avocado seedling roots. The antifungal lactone, borbonol-2, was present in roots of resistant and susceptibility field-grown avocado trees.

Effects of culture filtrate components on avocado cell cultures induced the inhibition of growth and the

induction of increased extractable activities of PAL, PO and PPO associated with accumulation of soluble and wall-bound phenolic material.

In this facet it was established that there are certain parameters that may be used as "markers" in the selection of tolerant cultivars or selections. The most important finding was the response of the peroxidase enzyme to resistance and infection. Increased activation of the PO enzyme and the appearance of two additional isoenzymes can be used with confidence. Other enzymes which also responded to infection were phenylalanine ammonia-lyase, indoleacetic acid oxidase and polyphenoloxidase. The antifungal lactone barbonol-2 cannot be used in identification as it appeared in the roots of both healthy and infected trees.

The second major finding was the establishment of a method whereby callus can be grown from certain avocado cultivars which was tested for the above reactions, this will save many years in selection and testing. The third finding was the extraction and identification of the phytotoxin from *P. cinnamomi* which could be used on cuttings as well as callus cultures in the tests for tolerance. By a combination of all these positive reactions it will not be possible to identify tolerance and/or resistance in the avocado.

DIVERSE SUBTROPICAL FRUITS

• Physiology

SS.2485/03/2/1: DIVERSE SUBTROPICAL FRUIT: DEVELOPMENT OF TISSUE CULTURE TECHNIQUES FOR THE PRODUCTION OF EMBRYOGENIC CALLUS AND PROTOPLASTS IN GRANADILLAS. 1984-1985
E. Louw

The aim of this facet is to develop techniques for the production of embryogenic callus and protoplasts in granadillas for the breeding and selection of plants that are tolerant to disease and environmental stresses.

Ex-plants from both the wild and the commercial granadilla were evaluated for their potential to produce callus. Young leaves of the wild granadilla were easily induced to form callus, but in the commercial granadilla these ex-plants failed to respond. The septa of young fruit was found to be more suitable for callus induction in the commercial granadilla. By manipulating the nutrient media and the physical conditions of incubation, organogenesis could be induced in the callus from leaf ex-plants of the wild granadilla.

DIVERSE SUBTROPICAL FRUITS

• Pathology

SS.2485/19/1/5: DIVERSE SUBTROPICAL FRUITS: CONTROL OF DAMAGE BY *BOTRYTIS CINEREA* ON HARVESTED GUAVAS. 1984-1986
D.H. Swarts

Guavas (cultivar Fan Retief) produced in the Paarl and Wellington districts were treated with fungicides over two consecutive seasons to control post-harvest decay and extend storage life.

During the first season, experiments were conducted on guavas that were almost eating-ripe. Fruit were chlorinated with 75 mg/dm³ available chlorine within 6 hours after harvest, followed by treatment with procymidone (150 g/100 l water) or thiabendazole (230 ml/100 l water). Half of the treated fruit were packed into polyethylene bags. All fruit were stored at 4,5 °C for 1, 2 and 3 weeks and at room temperature for periods ranging from 1 to 3 days depending on the storage period. The number of rotted guavas, fungi responsible and the type of decay caused by each, were recorded at weekly intervals. Although both fungicides decreased the incidence of decay significantly, the decay level remained unacceptably high.

Botrytis cinerea and *Mucor piriformis* were isolated from the majority of rotted guavas. Polyethylene bags had a detrimental effect on fruit quality. Guavas were also stored in a controlled atmosphere (10 % CO₂, 2 % O₂, 4,5 °C) for periods of 1, 2 and 3 weeks and evaluated as before. Quality after storage was not improved compared to that of control samples.

During the second season mature-green fruit were treated as before but the time between harvest and application of chlorine was varied. Storage and evaluation were done as during the previous season. Procymidone and thiabendazole controlled decay effectively for 2 weeks compared to control fruit, but the

incidence of decay was still too high. Chlorine had no effect on decay. *Botrytis cinerea*, *Mucor piriformis*, *Phomopsis psidii* and *Colletotrichum gloeosporioides* were consistently isolated from rotted fruit. *Phomopsis psidii* was the major fungus responsible for blossom-end rot, while *B. cinerea*, *M. piriformis* and *C. gloeosporioides* mostly caused side rots. No effective post-harvest treatment could therefore be recommended. Successful control of post-harvest fungus diseases of guavas could possibly be achieved by the application of appropriate fungicides in the orchard, followed by post-harvest fungicidal dips and correct handling.

DIVERSE SUBTROPICAL FRUITS

• Crop science

SS.2485 30 1 1: TESTING OF PRUNING SYSTEMS IN DIVERSE SUBTROPICAL FRUIT:
GUAVA. 1974-1984
A.J. Alberts

A guava pruning trial was carried out on Fan Retief guava trees at the Levubu Experiment Farm. The aim was to compare different pruning times in relation to time of harvesting. It was found that pruning time influenced the harvesting dates and yield as follows:

Month of pruning	Main harvest	Yield (ton/ha)
August/September	March-April	52,0
October	May-June	58,8
November	July-August	49,8
January	September-October	24,8

From the data it is recommended that trees should be pruned in October to obtain the highest yield. As it may be advantageous for farmers to prune earlier or later than October to spread their marketing season over a longer period, pruning should not be left as late as January.

DIVERSE SUBTROPICAL FRUITS

• Crop science

SS.2485 30 1 2: TESTING OF PRUNING SYSTEMS IN DIVERSE SUBTROPICAL FRUITS
WITH RELATION TO GUAVAS. 1974-1984
A.J. Alberts

Four guava pruning systems were compared, i.e. vase shape, severe, hedge and flat crown with relation to yield, fruit size and seasonal distribution of fruit.

During the 7-year production period of the trial, the vase shape pruning system performed the best with an average yield of 38,57 ton/ha annum, followed by flat crown 36,11 t; severe 25,11 t and hedge 16,06 t. The highest yield in a single year was achieved by the vase shape system namely 66,34 t/ha.

The fruit size of the three systems, vase shape, severe and hedge pruning did not differ significantly with $\pm 50\%$ medium and 35% large fruit. The flat crown yielded 50% medium and 17% large fruits.

The different pruning systems did not affect the seasonal distribution of the crop.

Nut crops

NUTS

• Anatomy

VV.2491/02/1/1: NUTS: ANATOMICAL STUDY OF PECAN CULTIVARS AT
ROODEPLAAT. 1981-1986
T.K. Haulik

An anatomical study concerning the differentiation of staminate and pistillate flowers of five pecan

cultivars with subsequent embryo development was conducted for four seasons (1981-1984). The pecan cultivars are part of the existing orchard at Roodeplaat and the five cultivars (Barton, Moore, Mahau, Urulinga and Success) are recommended for commercial cultivation for the Transvaal, Middle- and Highveld regions. Two different techniques were used to study the differentiation and development of the reproductive organs of the pecan; the Johanssen method with light microscopy, and hand sectioning with scanning electron microscopy. Eight different development phases of the staminate inflorescence was described and the times for each stage determined. According to observations the development followed the grouping of cultivars according to catcin length and not according to dichogamy as found by overseas investigators. The development of the pistillate inflorescence had five stages. No antigenetic differences between short and long catcin cultivars were noticed.

Thirteen stages were determined for embryo development from megaspore mother cell to hypocotyl appearance. Differences between seasons and cultivars were minimal. The fertilised endosperm nucleus was observed about 5-7 days after pollination, the egg nucleus about 18-22 days after pollination, while the embryo remained inactive for about 40 days. The pecan ovule is crassinucellate, the embryo sac is a monosporic polygonus type, the embryo is asterad and the endosperm is a nucleate type. In the case of pecan embryology the stained light microscopic observations proved to be easier to study than scanning electron microscopic observations.

Radioisotope

RADIOISOTOPE

- *Physics*

VV.24101/54/1/2: DETERMINATION OF SOIL MOISTURE AND DENSITY NEAR THE SOIL SURFACE WITH THE AID OF RADIOISOTOPE TECHNIQUES. 1979-1985
J.H.M. Karsten

The depth probe of the neutron moisture meter is generally accepted as an instrument with which soil moisture can only be determined at depths greater than 300 mm. The largest fluctuations in soil moisture occur at depths shallower than 300 mm which make this region of utmost importance for irrigation purposes. However, investigations showed that the depth probe of the neutron moisture meter is equally efficient for measurement near the soil surface. By using quadratic, instead of linear calibration curves, accurate soil moisture determinations were possible at depths as shallow as 100 mm.

The possibility of using the depth probe of the neutron moisture meter for moisture determinations in pot experiments was investigated. It was found that with careful calibration, acceptably accurate soil moisture determinations were possible in containers with volumes much smaller than the sphere of influence of the meter. Especially in very small containers, quadratic calibration curves were essential.

Sundry horticultural crops

HORTICULTURAL CROPS

- *Nutrition*

VV.24111/05/1/1: UPTAKE OF ^{32}P AND ^{65}Zn BY OLIVE LEAVES. 1982-1986
Odette Beukes

The effect of various wetting agents on the uptake and transport of foliar-applied nutrients was studied with radio-active labelled phosphorus and zinc solutions. Most of the uptake of foliar-applied nutrients took place through the abaxial leaf surface. Addition of the wetting agents Agridex, Agral, Citowet and Penetrex significantly increased uptake of phosphorus by leaves when compared to the control. All the wetting agents used significantly enhanced transport to shoots of foliar applied zinc when compared to the control. However, Alcopol-O far exceeded the other wetting agents.

HORTICULTURAL CROPS

• Nutrition

VV.24/11/05/2/1:

HORTICULTURAL CROPS: AVAILABLE PHOSPHATE AND POTASSIUM FOR ROOIBOS TEA. 1983-1986

M.E. Joubert

The reaction of rooibos tea to applied nutrients was investigated in pot experiments with seedlings. The plant has a low lime requirement but did respond favourably to small lime application, but at high lime rates growth was depressed. Best growth of rooibos tea seedlings was obtained at Bray (II) extractable P and K levels of 15 and 60 mg/kg soil, respectively.

Different carriers of these nutrients did not differ significantly. Growth of seedlings and uptake of K and Ca were greatly decreased at high phosphate application rates. Small applications of nitrogen had a beneficial effect on the growth of seedlings, even though root nodulation and apparently effective *Rhizobium* symbiosis did occur. Application of N to seedlings after planting may assist their establishment. However, at high soil-Mg content large applications of nitrogen decreased growth. Application of Mg decreased growth and it appeared as if the natural level of Mg saturation of the exchange complex of 10 % in the soil used was sufficient.

L value studies showed that the tap-root of rooibos tea is a stronger feeder for phosphorus than the lateral roots near the soil surface. Best utilisation of applied phosphate may therefore be expected if placement is restricted to the soil surface layer in the proximity of the young seedling. In the mature plant the tap-root may satisfy its relatively small phosphorus requirement from subsurface soil horizons.

Although the results obtained in this study cannot be applied directly in practice because of the more intense rooting in pots, they do serve as a guide in the planning of future fertilisation trials.

HORTICULTURAL CROPS

• Crop science

VV.24/11/30/10/1:

HORTICULTURAL CROPS: BUD DEVELOPMENT IN KIWIFRUIT UNDER DIFFERENT CLIMATIC AND GROWING CONDITIONS. 1983-1986

G.C. Linsley-Noakes

Three experiments were designed to investigate the effects of seasonal temperature on the reproductive development of two clones of kiwifruit - 'Hayward', a high winter chill-requiring cultivar; and 'Allison', a low winter chill-requiring cultivar.

Orchards representing three different climatic areas in Natal were chosen, representing cold, cool and warm winter areas.

The first experiment was designed to investigate the morphological development of the reproductive structures within the buds, so as to identify the processes adversely affected by insufficient winter chilling.

The second experiment was designed to investigate the chilling requirements of the two clones examined and to determine which of the rest-completion prediction models most accurately predicted vine productivity.

The third experiment was designed to investigate the importance of spring and summer temperatures on flower and fruit development.

The main findings of this research was:

- (i) The morphological experiments proved that flower initiation takes place in spring only, just before budbreak. Seven stages of flower primordial development were shown. It showed that the effect of winter temperature on vine productivity is far more important than was initially accepted. Flower initiation is extremely sensitive to inhibition by developing shoots. Insufficient winter chilling, which causes delayed and protracted foliation, results in the complete inhibition of flower development of all buds that break dormancy later than one week after initial budbreak. Where initiation is inhibited these primordia are non-functional. Any vegetative development from these buds is therefore from adventitious buds arising at their bases.

- (ii) The second experiment showed that the cultivar 'Allison' has a dramatically lower chilling requirement than 'Hayward' (400 and 1 000 Richardson chill units, respectively). Richardson chill units gave the best correlations between productivity and winter chilling.
- (iii) Flower and fruit development rates were very difficult to correlate with heat accumulation in spring and summer. 'Allison' vines required less heat accumulation in spring for budbreak than 'Hayward'.

The fruit in the warmest region were larger, but this was probably due to lower numbers of fruit per vine, rather than more heat accumulation. Fruit growth measurements show that kiwifruit may well show a triple sigmoid growth curve.

PLANT PROTECTION RESEARCH

Entomology/Zoology

MITES

• Pests

PB.2513/20/1/2:

FIELD EVALUATION OF PROMISING PESTICIDES AGAINST *TETRANYCHUS* SPP. 1977-1986

J.H. Botha

A number of aspects which might influence the build-up of spider mites on cotton were investigated.

In contrast to their numbers on cotton treated with some of the insecticides used to control *Heliothis armiger* (Hübner) in field trials, the numbers of spider mites remained very low in the unsprayed cotton. Predators such as especially the pirate bug, *Orius thripoborus* (Hesse), appear to play an important role in maintaining mites in untreated plots at low population levels. Predator numbers were significantly reduced by some of the insecticides used. It is, however, not yet clear how the predator complex as a whole affects mite numbers.

When deciding on the use of an insecticide the effect thereof on insects as well as on mites should be brought into consideration. Out of the insecticides tested, the use of flucythrinate and fenvalerate yielded the highest seed cotton harvest. These insecticides have moderate mite suppressive properties and seem to control other pests to some extent.

Observations under laboratory conditions indicated that no obvious relation exists between the contact toxicity of the various insecticides tested and the build-up of spider mite populations on field cotton. The organo-chlorine, endosulfan, has the lowest contact toxicity of all the insecticides tested. Despite this, spider mite numbers on field cotton treated with endosulfan were lower than in any of the other treatments. In some cases the selective survival of predators may have had an important effect on mite populations. In this particular case no definite explanation could be found for the results obtained.

As far as the chemical control of spider mites is concerned, the acaricide triazophos was sprayed at different times in the cotton growing season. The evaluation of the profitability of a specific control strategy was complicated by unforeseen variation in some of the variables. When reduction in spider mite populations and the prevention of yield loss are taken into consideration, early control was generally the most successful strategy. *Tetranychus cinnabarinus* (Boisduval) populations were found to be more susceptible to triazophos applications than *Tetranychus lombardii* (Baker & Pritchard) populations. This tendency was observed under both field and laboratory conditions. These results are not necessarily applicable to populations of these species in other regions.

A simulation model for spider mite population build-up was constructed. At this stage the function of the model is mainly to provide an estimate of how *T. cinnabarinus* numbers would be affected by specific conditions. As basic input, extensive data by earlier researchers are used. A series of submodels were added, and consequently interesting investigations with respect to the population dynamics of *T. cinnabarinus* were obtained.

Based on the important gaps in knowledge as identified through using FLEXTET and other research tools, some recommendations for future research are made. The need to understand the whole cotton plant agro-ecosystem as well as the full implications of changes to this system are highlighted. It is suggested that integrated control as currently practiced on South African cotton should be refined to include a thorough consideration of the damage potential of both insects and mites as related to the existing predator complex.

FUNGI

• Pathology

PB.2521/19/1/1:

STUDY OF SEED BORNE PATHOGENS: FUNGAL PATHOGENS ON MISCELLANEOUS LOCALLY PRODUCED AND IMPORTED SEED SAMPLES. 1975-1986

M.A. Holtzhausen

From 1978 to 1985 1 674 seed samples representing different crops were tested for the presence of seed-borne pathogens. Standard methods of incubation as recommended by the International Seed Testing Association for seed health testing were used. This involved mainly the incubation of seeds on moist filter paper or agar plates at 20 °C and under intermittent irradiation, for 12 hours/day, near ultra-violet light. After 5 to 10 days the seeds were examined for the presence of pathogenic fungi. A synopsis of the different crops from which seed samples were tested and the different fungal pathogens identified were listed.

The results indicated that valuable information on the presence of pathogenic fungi on seed samples can be obtained by this type of examination. The presence of certain specific pathogens as well as the extent of the infestation of seeds, can be determined. Also the presence of seed-borne pathogens which are not known to be present in South Africa, may be detected in this manner. These tests are useful to guard against the importation of dangerous pathogens not known to occur in South Africa.

BACTERIA

• Nitrogen fixation

PB.2522/09/1/9:

APPLICATION OF NITROGEN-FIXING BACTERIAL INOCULANTS BY MEANS OF IRRIGATION SYSTEMS TO LEGUMES. 1984-1985

J.L. Staphorst

The traditional seed inoculation of legumes is regarded as unpractical by producers planting large amounts of seed during peak times as is common practice by commercial producers of peas. The success of so called "pestigation and fertigation" where metered amounts of pesticides and fertilisers are introduced in the irrigation water has led to interest in the possibility of applying legume inoculants in a similar way.

Normal seed inoculation applied at the recommended dosage of 250 g peat-based inoculants results in $2,5 \times 10^8$ *Rhizobium* cells being deposited on each single seed. Where inoculants are applied at the dosage of 250 g inoculant per hectare through the irrigation system, only $1,25 \times 10^3$ *Rhizobium* cells are in contact with the individual seed. A 200-fold reduction in cells/seed is thus obtained while using 5-6 times the amount of inoculant compared to traditional seed inoculation.

Greenhouse trials with 6 different soils to which increasing amounts of inoculant were applied in the irrigation water confirmed the availability of relatively small numbers of rhizobia available for nodulation by this method. Only where the inoculant dosage was increased ten-fold was satisfactory nodulation obtained in 5 of the 6 soils used. As the minimum area under centre pivot irrigation is approximately 30 hectare, a ten-fold inoculant dosage would entail the application of 300 units of inoculant.

Practical problems with sedimentation of the peat-carrier as well as blocking of metering pumps with this amount of inoculant is unavoidable. The extra cost of these relatively large amounts of inoculant needed would also act as a deterrent against the widespread use of this method.

Field observations made at adjacent sites where seed inoculation and inoculation by irrigation was applied by a few pea-producers in the Marble Hall district, confirm the results of the greenhouse trials. Only sparse nodulation was obtained where the irrigation method of inoculation was used at the rate of 250 g inoculant per hectare. Nodulation was found to be excellent in adjacent sites where seed inoculation was used.

Inoculation of annual legumes by means of irrigation systems cannot be recommended. It may however be a viable remedial method for perennial legumes where normal seed inoculation has been omitted or found to be unsuccessful. In this case the natural build-up of the *Rhizobium* from the inoculants in the soil can be

expected to result in satisfactory nodulation during the following season.

The possibility of applying concentrated liquid inoculants directly to the seed during the planting operation is presently being evaluated by the Rhizobium section.

PASTURE CROPS

• Pathology

PB.2526/19/1/5: EVALUATION OF DISEASE RESISTANCE IN PASTURE CROPS GROWN IN THE WESTERN CAPE: *MEDICAGO* SPP. 1981-1985
S.C. Lamprecht

Annual *Medicago* species (medics) are important pasture crops in South Africa and resistant cultivars should be considered in disease control. Medic accessions in experimental plots at 12 locations in the Winter Rainfall Region of South Africa were scored for severity of foliage diseases during 1982. Disease severity varied among the different accessions. Most accessions showed intermediate ratings at all locations. *Medicago aculeata* had notably low ratings, whereas *M. truncatula* cv. Cyprus had high ratings.

The reaction of 44 accessions of medics to foliar infection by *Colletotrichum trifolii* was tested in a glasshouse. Medic accessions differed significantly in their reaction to the fungus. *M. truncatula* cv. Jemalong and *M. scutellata* cv. Robinson were significantly more susceptible and *M. truncatula* cv. Borung and cv. Cyfield were significantly more resistant. Seedlings were more susceptible than older plants. Highly susceptible accessions should be avoided in areas where *C. trifolii* is a problem.

The reaction of commercially available cultivars of medics to crown rot caused by *C. trifolii* was tested under glasshouse conditions. *M. truncatula* cv. Jemalong and *M. scutellata* cv. Robinson were significantly more susceptible and *M. truncatula* cv. Borung and cv. Cyfield were significantly more resistant. Crown rot severity and yield loss were found to be correlated and significantly less yield loss occurred in the more resistant cultivars. Mechanically injured crown tissue showed a tendency to develop more crown rot than uninjured crown tissue. Resistant cultivars represent the only economical control of *Colletotrichum* crown rot of medics.

PASTURE CROPS

• Pathology

PB.2526/19/1/8: EVALUATION OF RESISTANCE OF LEGUME PASTURES AGAINST FUNGUS DISEASES. 1984-1986
L.J. Mills

The resistance of different legume pasture cultivars to diseases caused by some of the most important pathogens was determined. Resistance experiments were carried out with the individual pathogens using the most popular legume pasture cultivars.

The results showed that Safari (*Trifolium semipilosum*), Kenland, Pawera and Hamua (*T. pratense*) were resistant to *Uromyces trifolii-repentis* var. *Trifolii-repentis* in the glasshouse and in commercial fields. Tamar (*T. repens*) was significantly more susceptible than the other cultivars and often became severely infected in the field. Palestine Strawberry (*T. fragiferum*) was more susceptible than the *T. pratense* and *T. semipilosum* cultivars. On average 42,7% of the white clover plants and only 13,7% of the red clover plants, were infected.

Disease control of *Fusarium* root rot should be directed at management practices that reduce plant stress, or to selecting plants tolerant of such stress and at breeding or selecting for resistance to both root and foliar diseases. The sowing of a susceptible clover cultivar after a previous susceptible cultivar in a cropping sequence should be avoided. The heavy losses in plant material, as a result of the disease, emphasize the importance of applying one or more of these control measures to prevent the build-up and spread of the pathogen.

No *Meloidogyne javanica* galls developed on Safari at Ermelo in the field whereas Dusi roots were covered with galls. Significantly less *M. javanica* galls developed on Safari (*T. semipilosum*) and the *T. subterraneum* cultivars Seaton Park, Geraldton, Trikkala and Daliak than on the *T. pratense* cultivars

Pawera and Turoa in the glasshouse. Between 1979 and 1985 no galls were observed on more than 100 *T. subterraneum* plants (Geraldton, Woogenellup, Clare Mount Barker) that were examined in the south-eastern, southern and south-western Cape Province. Clover cultivars with a high root knot index such as Turoa and Pawera (*T. pratense*) should be avoided unless they have other agronomic characters of particular value.

ANIMAL PRODUCTION PROMOTION

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH

Animal production

DAIRY CATTLE

- *Reproduction*

VS.3112/04/1/1:

MILK PROGESTERONE CONCENTRATIONS: AN ACCURATE EARLY PREGNANCY DIAGNOSTIC AID IN DAIRY CATTLE. 1982-1986

G.W. Kay, J.P. van Zyl and R.T. Naudé

The aim of the present study was firstly to emphasise the importance of the correct day of sampling to give maximum diagnostic efficiency, secondly, to compare the methodology and diagnostic efficiency of the radioimmunoassay (RIA) and the enzymeimmunoassay (EIA), and thirdly, to verify the stability of potassium dichromate-preserved samples, stored under extreme conditions, simulating those that may be found in hot climates.

RIA - using a limit of 1 ng progesterone/ml, animals were diagnosed as pregnant or non-pregnant. These diagnoses were compared to the reference pregnancy test diagnosis, and the efficiency of the milk test expressed in terms of the positive predictive value and the negative predictive value.

The positive predictive values rise slowly reaching a maximum of 100% on day 22 post-insemination, whereas the negative predictive values rise sharply reaching values of 90% on day 18 and reaching a maximum of 100% on day 23.

EIA - using the progesterone values obtained from day-22-samples, the animals were classified as pregnant or non-pregnant and then related to the reference pregnancy test diagnoses. A positive predictive value of 93,8% and a negative predictive value of 94,2% for the test was obtained for day 22 after insemination.

This study confirms that temperatures of 25°C and 37°C do not adversely affect the progesterone values although there were markedly high coefficients of variation on determinations made on the same sample stored for different times. Exposure of the preserved samples to direct sunlight caused a deterioration in the physical condition of the sample but not the progesterone content.

PIGS

- *Nutrition*

VS.3119/05/1/3:

SOME ASPECTS OF CHEMICAL AND PHYSICAL DEVELOPMENT OF LEAN AND OBESE PIGS DURING GROWTH. 1980-1985

F.K. Siebrits

The purpose of this study was to quantify the development of chemical body composition and in particular protein in the growing pig with the aid of the allometric autoregression (AA) model. This was done to establish the animal's potential for the deposition of protein at any given stage of development in order to determine the dietary protein requirement at this stage. A further aim was to determine whether sex (boars or gilts) and type (lean or obese pigs) has an effect on the development of the pig and to establish to what extent the present grading system can adequately accommodate different types of pigs.

Fifty pigs of each type, fed an adequately balanced diet *ad lib* were slaughtered sequentially between 20 kg and 110 kg live mass. The left side of each carcass as well as blood and entrails were chemically analysed, while physical measurements were made on the right side. The AA model was used to statistically analyse and describe growth and body composition.

Lean boars had the highest average growth rate (836 g/day) followed by obese boars (816 g/day), obese gilts (717 g/day) and lean gilts (679 g/day). The feed intake pattern of all the pigs was such that a peak intake rate was reached with a subsequent decline. Obese pigs maintained a higher intake than lean pigs while boars consumed more feed than gilts.

Both sex and type affected the quantity of body fat, gilts having more than boars and, naturally, obese pigs having more than lean pigs. Body protein content, expressed as a percentage of empty body mass, remained relatively constant at about 17% in all the groups between 30 and 100 kg live mass. Protein deposition rate of all the groups increased curvilinearly to reach a maximum rate with a subsequent decline. Lean boars reached a maximum of 156 g/day, between 60 and 70 kg live mass. Obese boars had a maximum rate of 144 g/day, lean gilts 121 g/day and obese gilts only 101 g/day between 40 and 50 kg live mass.

Body moisture content decreased during the live mass interval 30 to 100 kg, indicating that the process of fattening is accompanied by an increase in the dry matter content of grain.

It was concluded that the pattern of energy retention is dictated by the pattern of energy intake but that the apportionment of energy towards protein and fat is genetically and sexually (probably hormonally) controlled, depending on the propensity of the pig to deposit protein. Sex, type and live mass had no effect on the amino acid composition of body protein.

The current grading system in South Africa does not discriminate sufficiently against obese pigs in the lower carcass mass categories. The selection against back fat in the lean pigs led to a shift in the site of fat deposition; possibly to the abdominal region. Sex has no effect on the relative growth and distribution of meat in the "expensive cuts" but the type of pig has.

The "ideal protein" requirements of the various experimental groups at different live masses were estimated using the results obtained in the present study.

Animal products

MILK

• Microbiology

VS.3123/08/3/3: THE SUITABILITY OF A SELF-SERVICE DISPENSER FOR RETAIL DISTRIBUTION OF MILK. 1985

H. Lück

The average increase in the temperature of milk after being stored in an "abomat" dispenser at 30 °C for 48 h and tapped into a consumer bottle was 3,6 to 4 °C. The initial temperature of the milk at filling should, therefore, be as low as possible (1 to 3 °C).

During operation the 1-l measuring device of the dispenser head is always filled with milk. This device is difficult to insulate and therefore to prevent this milk from deteriorating, the dispenser head should be kept overnight at refrigeration temperatures or a new, clean head should be used every morning. When both container and dispenser head, were kept overnight in a cold room (5 °C) the average temperature of the milk did not increase significantly after 48 h.

The lower the initial total bacterial count and the temperature of the dispenser milk, the longer the storage period before critical total bacterial counts were reached. The number of psychrotrophs, thermotolerant bacteria and coliforms followed the same trend. Pasteurised milk with an initial total count of less than 10 000/m^l could be maintained in an acceptable condition for at least 2 days at an ambient temperature of up to 30 °C.

The bacterial count of the filling valve determined by the swab method had no significant influence on the bacteriological quality of the milk tapped from the dispenser.

Dispenser milk sold in Port Elizabeth contained on an average less total bacteria, psychrotrophs and thermotolerant bacteria than pre-packed milk distributed by the same dairy factory under similar conditions but stored in refrigerated display cabinets of supermarkets.

No basic disadvantages of the dispenser system were observed during the practical use of the "abomat".

The present regulations should be amended to make provision for the use of self-service milk dispensers under specified conditions.

Supporting animal research

ANIMALS

• Nutrition

VS.3133/05/1/8:

FEED INTAKE IN THE FEEDING OF FARM ANIMALS: RELATIONSHIP BETWEEN RUMEN FILL AND ENERGY BALANCE ON ROUGHAGE DIETS.

P.H. Henning

1983-1986

The aim of this experiment was to test the hypothesis that the difference between energy demand and energy supply may effect the rumen digesta content in such a way that the larger the energy deficit the greater the upper limit to organic matter (OM) accumulation in the rumen with a concomitant increase in intake. Walking exercise was chosen as the means to increase energy demand of the sheep.

Twelve matur S.A. Mutton Merino sheep fitted with rumen cannulae were used. All animals received an *Eragrostis tef* diet *ad libitum* in a continuous feeding regime. Six animals served as controls for possible time effects whereas the other six underwent an exercise regime where *full exercise* lasted for a period of two weeks and consisted of 9 km/day at 3 km.h⁻¹ against a 10° gradient on a treadmill.

The respective values for OM intake, rumen OM contents and empty body mass decreased significantly ($P < 0.01$) from 1 347 g, 956 g and 47,6 kg during the *pre-exercise period* to 1 177 g, 803 g and 44,4 kg during the *full-exercise period*. There were no significant differences in mean rumen retention times of fermentable OM, unfermentable OM and water between treatment periods.

The results indicate that changes in the upper limit to OM accumulation in the rumen, such as is observed for example in the lactating dairy cow, is not a direct result of a change in energy balance.

ANIMALS

• Nutrition

VS.3133/05/3/2:

RUMEN BACTERIA DIGESTING POOR TEFF HAY PLUS NITROGEN AND CARBOHYDRATE SUPPLEMENTS FED TO SHEEP. 1969-1983

J.J. Therion

This study was conducted to determine whether supplementation of low-protein teff hay with 3% urea and 6% starch would result in proliferation of amylolytic bacteria, which in turn would supply branched chain volatile fatty acids (BCVFA's) to the fibre-digesting bacteria and ultimately enhance fibre digestion and improve the performance of animals on low quality hay diets.

Four Merino wethers were adapted to the two diets *viz* teff hay supplemented with 3% urea and teff hay supplemented with 3% urea and 6% starch.

There was no difference in the performance of the sheep on the two different diets and the 6% starch in addition to the urea supplement had no effect on hay consumption, digestibility or flow rates. The percentage composition of the bacteria digesting each diet was calculated. For the diet supplemented with 3% urea the bacterial composition was 6% cellulolytic, 59% xylanolytic, 64% amylolytic and 89% glucolytic. When the supplement was 3% urea plus 6% starch there was 6% cellulolytic bacteria, 63% xylanolytics, 56% amylolytics and 90% glucose-fermenting bacteria. From these figures it is clear that the composition of the microbial population was very similar for both diets.

Since there was no increase in the numbers of amylolytic bacteria with the addition of the starch supplement, there was presumably no increase in the concentration of BCVFAs and no proliferation of cellulolytic bacteria. The intended effect was probably not achieved due to the fact that the starch and urea supplement was sprayed onto the teff hay, resulting in an even distribution throughout the batch of hay. Therefore, the starch was released evenly, according to the rate of intake, with the result that at no time there was a high ruminal starch concentration which could support rapid multiplication of amylolytic bacteria, followed by a low concentration some hours after feeding when lysis would occur owing to

starvation, releasing the BCVFAs. In order to obtain rapid multiplication of starch-fermenting bacteria, it would be necessary to administer the supplement as a dose per ruminal cannula. However, when this was done, the animals died of NH_3 -poisoning and acidosis.

In conclusion, no noteworthy benefit in terms of food intake, digestibility or rate of passage was achieved from supplementing the teff hay diet with urea and starch.

ANIMALS

• Nutrition

VS.3133/05/3/3: STUDIES OF THE BACTERIA RESPONSIBLE FOR BREAKING DOWN
BIURET IN THE RUMEN. 1963-1983
F.M.C. Gilchrist

A positive response by ruminants to supplementation of their rations with biuret as a non-protein nitrogen source has often been observed to be preceded by a period in which the benefit was delayed or small. This study was conducted to require knowledge about the adaptation period necessary before animals would benefit from the supplementation of their diet by biuret, as well as to determine the factors influencing the adaptation. Since a basal diet with low protein content seems to provoke a positive response to biuret feeding in comparison with a negative response with a good quality roughage, the biuretolytic activity of ruminal ingesta of sheep fed very low, medium and somewhat higher protein rations was determined.

The possible influence of starch as well as protein supplementation on biuret activity was also measured. A study was also made of the end products of biuret breakdown *in vitro* by unstrained ruminal ingesta from sheep adapted to biuret to obtain information about the mechanism by which biuret becomes available to the ruminant.

When biuret was added to the diet there was a marked increase in biuretolytic activity and the rate at which maximum activity developed was related to the protein content of the diet. The lower the protein content, the more rapidly the activity increased. The beneficial effect of starch on the biuretolytic activity *in vivo* suggested that the multiplication of biuretolytic organisms was favoured by the addition of readily available carbohydrate starch supplementation. Casein and egg albumin supplementation had no direct effect on biuretolytic activity *in vitro*, suggesting that protein was not inhibitory.

Results also showed that biuret nitrogen can be converted to ammonia nitrogen by ruminal ingesta irrespective of the dietary conditions. The adaptation of an animal to biuret is thus a question of developing a ruminal flora which can break down biuret to NH_3 at an adequate rate.

Enrichment cultures containing rumen fluid from sheep fed lucerne hay produced true enrichments of the coccobacilli associated with biuretolytic activity. Attempts to isolate the active biuretolytic bacteria were unsuccessful and it appears that co-cultures may be required to break down biuret.

ANIMALS

• Nutrition

VS.3133/05/3/5: METHODS FOR RELEASING BACTERIA AND PROTOZOA FROM
SOLID PARTICLES OF DIGESTA. 1976-1986
R.I. Mackie

Since many species of rumen bacteria tend to be preferentially attached to the solid particles of ingesta, it is necessary to free these bacteria prior to making viable counts in any ecological study. Most studies, including those in our laboratories, have used bladed homogenisers to release bacteria from ingesta particles but it appeared that this technique damaged some of the large bacteria and protozoa. Although the Stomacher has not been used for processing samples of ruminal ingesta, it was thought that it offered a more gentle method than the ultra-turrax homogeniser so that most of the protozoa and large bacteria would survive.

The Stomacher has two paddles, side by side, which alternately pound a polyethylene bag containing

the sample and diluent thus compressing the contents against the flat surface of the door. Removal of the micro-organisms is probably brought about by shearing forces as the liquid is swept from side to side, and partly by a series of rapid compressions under the paddles. It has the added advantage that sample and diluent are isolated in a bag from the working surfaces, and that increases in temperature are small compared with those produced by bladed homogenisers. Thus a comparison was made of the effect of different methods of processing ingesta on viable counts of different metabolic groups of organisms. Initially processing was performed under a stream of anaerobic gas and counts were made using the roll tube technique. In later experiments processing was done in an anaerobic cabinet and counts were made using the plating technique.

Although anaerobic precautions were taken when processing ingesta outside the cabinet, it was not possible to prevent oxidation of anaerobic diluent, or shown by the indigocarmine redox indicator. When the three methods were ranked according to degree of anaerobiosis i.e. Minimal> Stomacher> Ultra-Turrax, it can be seen that the Ultra-Turrax was the least anaerobic and the Minimal treatment the most anaerobic. However, the effectiveness of the treatments for removing bacteria from solid particles of ingesta was Ultra-Turrax> Stomacher> Minimal, as shown by scanning electron micro-photographs. Thus the count of the different metabolic groups of organisms is influenced by opposing actions which release and destroy or inhibit to varying extents the different species of which the group is composed. Thus poor anaerobiosis was responsible for at least some of the lethal action of the Ultra-Turrax and Stomacher.

This was confirmed by a series of experiments in which both processing and plate counts were performed inside an anaerobic cabinet. Counts of total culturable, lactate-utilisers and cellulolytic bacteria all increased 2-3-fold when the Minimal and Stomacher or Ultra-Turrax treatments were compared on both the lucerne hay and high concentrate diets (see Table 1). Furthermore, experiments performed on two pure cultures of rumen bacteria (*Bacterioides amylophilus*, *Selenomonas ruminantium*) processed by the three different methods within the anaerobic cabinet showed no reduction in either direct microscopic or viable counts.

The results of the experiments can be summarised as follows:

- (i) The Ultra-Turrax homogeniser was the most effective treatment for removing bacteria from solid particles of ingesta;
- (ii) reduced anaerobiosis when processing samples of ruminal ingesta outside the cabinet is an important factor causing a decrease in counts of viable ruminal bacteria;
- (iii) there is no evidence of mechanical damage to the cells in pure culture studies although bacteria attached to particles may be damaged by mechanical removal;
- (iv) high counts were obtained when ingesta samples were processed and plated out within the anaerobic cabinet.

TABLE 1 - Effects of different processing methods on numbers of bacteria in different metabolic groups using the anaerobic cabinet for ingesta processing and plate counts

Diet and metabolic group	No. of bacteria (X10 ³ per g ingesta) as determined after processing ^a		
	MN	ST	UT
Lucerne hay (n=5)			
Direct microscopic	17,9	31,3	39,4
Total culturable	4,3	8,9	12,9
Lactate utilisers	2,3	6,1	10,6
Cellulolytics	0,04	0,71	0,87
High concentrate (n=6)			
Direct microscopic	60,8	99,7	106,0
Total culturable	29,7	61,7	68,2
Lactate utilisers	21,7	49,5	54,6
Cellulolytics	1,4	2,8	3,3
Pure cultures (n=3)			
<i>Bacterioides amylophilus</i>	3,1	3,3	3,2
<i>Selenomonas ruminantium</i>	5,0	4,9	4,9

a MN - Minimal treatment with manual swirling in anaerobic diluent at 1/10 dilution to suspend ingesta particles
ST - Stomacher treatment for 1 min at 1/10 dilution in Colworth Stomacher 400
UT - Ultra-Turrax treatment for 1 min at 1/10 dilution in Ultra-Turrax homogeniser (20 000 rpm)

• Nutrition

VS.3133/05/3/10:

DETERMINATION OF POSSIBLE FACTORS (HORMONAL AND METABOLIC) LEADING TO THE UNUSUALLY HIGH FREE FATTY ACID (FFA) LEVELS ASSOCIATED WITH STARVATION IN SHEEP.
1977-1986

S.L. Campbell

Karakul and Namaqua-Afrikaner sheep, both of which are fat-tailed breeds, were examined for suitability as models for studying lipid metabolism *in vivo*. The anatomy of the blood supply to the hindquarters of both breeds was examined, and a technique developed for sampling the venous outflow from the fat tail. The composition of the tail and the rest of the hindquarters was determined and found to be similar in both breeds. The hindquarters contained 35 % fat, about half of which was located in the tail (72-74 % fat).

Rates of blood flow through the whole hindquarters, tail adipose tissue and leg muscle of Karakul ewes were measured. Tritiated water (TOH) was used for measurement of specific blood flow and para-aminohippuric acid (PAH) for measurement of absolute blood flow. The specific blood flow rate for tail adipose tissue was $3,62 \pm 0,12 \text{ ml min}^{-1}$ per 100 g and absolute blood flow was estimated as $74 \pm 7 \text{ ml min}^{-1}$. The absolute flow through the rest of the adipose tissue in the hindquarters was similar to that flowing through the tail, and together they represented about 15 % of the total absolute flow through the whole hindquarters, $794 \pm 131 \text{ ml min}^{-1}$, measured directly using PAH. Total blood flow through the hindquarters estimated from the specific flow rate (using TOH) and the mass of the hindquarters was $761 \pm 50 \text{ ml min}^{-1}$. The absolute blood flow through the hindquarters of Namaqua-Afrikaner ewes ($626 \pm 39 \text{ ml min}^{-1}$) was lower than that measured in the Karakul ewes, but the difference was not significant ($P=0,01$).

The rates of net release from tail adipose tissue of Karakul ewes measured *in vivo* were $3,0 \pm 0,6 \mu\text{mol min}^{-1}$ per kg and $2,0 \pm 0,2 \mu\text{mol min}^{-1}$ per kg for free fatty acids and glycerol, respectively. Intravenous infusion of noradrenalin ($2 \mu\text{g min}^{-1}$ per kg live mass) increased venoarterial differences of both free fatty acids and glycerol 2- to 3-fold and blood flow increased by about 60 %. As a result, in response to noradrenalin, net releases for both free fatty acids and glycerol increased 4-fold.

ANIMALS

• Nutrition

VS.3133/05/6/5:

DIETARY COMPONENTS IN FEEDS FOR ANIMAL FEEDING: WHOLE MAIZE GRAIN. 1984-1985

J.P. Campher

Since it can be accepted that mastication and also subsequent rumination are the only means by which the pericarp of whole maize grain can be penetrated in order to facilitate digestion, it can be postulated that improved mastication and rumination would lead to improved digestion and possibly intake. Among the many possible factors influencing these processes it was thought that hardness of the grain is of major importance.

Twelve mature beef cows (ca. 450 kg live mass), with no previous experience on whole maize grain feeding systems, were randomly divided into four groups of three each. Two grain cultivars, i.e. hard endosperm (PNR 542) and soft endosperm (HL2) were fed either dry (natural basis) or soaked for 24 hours to ca. 81 % dry matter, thus giving a 2x2 factorial design. The grain was mixed with 3 % molasses and 3 % of a high protein concentrate. In addition to this 10 % milled *Eragrostis curvula* hay was fed in separate troughs. After an initial 7-day adaptation period a 17-day digestibility trial was conducted.

The *in vivo* apparent dry matter digestibilities of the four diets, i.e. PNR 542-dry, PNR 542-soaked; HL2-dry and HL2-soaked, were 77,41 %; 75,10 %; 80,16 % and 72,39 %, respectively. Corresponding values for total dry matter intake for the respective groups were 5,06 kg/day; 5,73 kg/day; 8,67 kg/day and 6,40 kg/day. Using this data the calculated daily metabolisable energy intake values were 59,9 MJ/day; 65,8 MJ/day; 106,3 MJ/day and 70,6 MJ/day. From this data it is apparent that the softer cultivar (HL2), in

either the dry or soaked state led to higher apparent dry matter digestibilities, higher dry matter intakes and hence higher metabolisable energy intakes. However, soaking either grain cultivars did not improve any of the parameters. This does not corroborate the general principle that reconstituting whole maize grain will improve performance.

It can be concluded that feeding softer grain cultivars may be beneficial to the animal.

VETERINARY RESEARCH

Pathological investigations

PATHOLOGICAL INVESTIGATIONS

• Pathology

OP.3211/19/2/3: PATHOLOGICAL INVESTIGATIONS ON AND PATHOGENESIS OF
AFRICAN SWINE FEVER. 1981-1985
J.A. Naser

African swine fever (ASF) is a disease of domestic and wild pigs caused by a virus of uncertain classification. The course of the disease in pigs varies, but classically it is responsible for acute death, widespread haemorrhage being the most prominent change. Haemorrhage in acute ASF may follow vascular damage as a result of replication of the virus in endothelial cells, thrombocytopenia, defective fibrin clot formation, or a combination of these. Based on their failure to detect virus antigen in platelets from infected pigs and the ability of soluble virus antigen to induce aggregation of thrombocytes obtained from infected pigs, previous workers also proposed an immune-mediated thrombocytopenia as pathogenic mechanism.

In the present investigation we studied the blood platelets of experimentally infected pigs by means of transmission electron microscopy. Replicating and mature viral particles were detected in animals infected with both virulent haemadsorbing and non-haemadsorbing African swine fever virus. Although platelet numbers decreased terminally in infected pigs, the most noticeable morphological damage to these cells apparent in the last 2 days of the disease included cytoplasmic swelling, vacuolation, fragmentation and loss of dense granules.

In contrast to previously published work, these results suggest viral replication in, and cytopathology of the thrombocyte to play a role in the pathogenicity of ASF.

PATHOLOGICAL INVESTIGATIONS

• Pathology

OP.3211/19/2/7: EVALUATION OF METHODS FOR *POST-MORTEM* RECOGNITION OF
TOXIC INJURY OVINE MYOCARDIUM. 1984-1985
S.J. Newsholme

Dried, milled *Dichapetalum cymosum* leaves were used as source of sodium monofluoroacetate since a batch of leaves of known toxicity was available. Five sheep were given a single, supra-lethal dose of *Urginea sanguinea* and 6 sheep were given *D. cymosum*. In addition, formalin-fixed hearts from 6 sheep poisoned by *D. cymosum* in a separate project were utilised.

Nineteen hearts from Onderstepoort abattoir were used as controls. This number was found to be sufficient for the myocardial potassium/sodium (K/Na) ratios since the standard deviation was small.

Samples of pericardial fluid were collected at necropsy from 2 of the sheep poisoned with *U. sanguinea* and 2 sheep poisoned with *D. cymosum*. Control samples were taken from 20 abattoir sheep. These samples were assayed for activities of the following enzymes:

- Total lactate dehydrogenase (LDH),
- alpha hydroxybutyrate dehydrogenase (HBDH),
- total creatine kinase (CK) and
- aspartate aminotransferase (AST).

This was prompted by a recent report that certain enzymes in pericardial fluid are significantly elevated in human cardiac deaths in contrast to deaths from non-cardiac causes.

All the sheep given *U. sanguinea* and *D. cymosum* died after an interval which ranged from 4-26 h.

Light microscopical examination of sections of myocardium revealed small foci of necrotising myocarditis scattered throughout the ventricles in most of the sheep which survived for longer than 15 h after receiving *U. sanguinea* or *D. cymosum*. Unequivocal evidence of myocardial injury, however, could not be detected in HE sections from sheep that died sooner than this.

The HBFP method identified myocytes which corresponded with necrotic ones in HE sections from sheep that had lived for more than 15 h, but myocytes did not retain fuchsin in sections from sheep which died sooner.

Yellow epifluorescence could be seen in only a few myocytes which were frankly necrotic in HE sections.

No significant differences could be demonstrated between the K/Na ratios for the control hearts and those from sheep poisoned with *U. sanguinea*. The ratios from hearts of sheep poisoned with *D. cymosum*, however, were slightly but significantly lower than those of controls.

Considerable variation in the level of enzymes in the pericardial fluid was found for the control group. Since only 4 poisoned sheep were sampled, statistical evaluation is not possible, but several of the enzymes, particularly CK, appear to be increased in both the sheep poisoned with *D. cymosum* and in one of the sheep poisoned by *U. sanguinea*.

In our hands, both the HBFP method and tissue epifluorescence failed to detect myocardial injury earlier than in HE sections. Neither of these methods, therefore, has any advantage over routine HE staining and cannot be recommended for routine diagnostic use. The failure to demonstrate significant differences between the K Na ratios of the control hearts and those from sheep poisoned with *U. sanguinea* was disappointing. It was also somewhat unexpected, since cardiac glycosides are known to inactivate cell membrane ATPase-dependent sodium transport.

The slightly but significantly lower ratios in hearts of sheep poisoned with *D. cymosum* apply only to the groups, but the method might be applied where a number of dead sheep from an outbreak of suspected *D. cymosum* poisoning is available. The specificity of this change in ratio, however, and the possible effect of *post-mortem* autolysis have not been evaluated.

The figures for the pericardial fluid enzymes are not sufficient to reach firm conclusions, but we believe that the few results obtained invite further investigation of this aspect.

Food hygiene

ANIMAL FOODS

• Pathology

OP.3221 19 2 1:

ANIMAL FOODS: TISSUE REACTIONS AND ANTIBIOTIC RESIDUES IN
SLAUGHTER STOCK INJECTED WITH LONG-ACTING ANTIBIOTICS.
1981-1985

J.J. van Staden

An investigation was performed on the tissue compatability, antibiotic residue as well as the humane aspect, after administration of different long- and short-acting oxytetracyclines in the thigh and neck of adult cattle. For every product tested 10 cattle were injected on day one and one was slaughtered every week thereafter for ten weeks. The carcasses were examined according to regulations laid down by law. Only in about 2.5% of carcasses, lesions were detected on the surface while the rest appeared normal and were passed by the meat inspector as fit for human consumption.

The results showed that tissue changes obtained were unexpected, both in severity as well as in their duration. Local intramuscular necrosis was still seen with some long-acting and short-acting products after 7 and 5 weeks, respectively, with abscessation up to 10 weeks. In contrast the withhold period after treatment of the animal from slaughter, stated by the manufacturers, is a maximum of 28 days. Antibiotic residues in the lesions, were present until 7 weeks after treatment with some products.

Remedies formulated for intramuscular use, should show accepted tissue compatability from a humane

point. Through this study we hope to draw a line between those products acceptable and those not acceptable.

ANIMAL FOODS

• Pathology

OP.3221/19/3/2:

FOOD HYGIENE: ANTIBIOGRAMS OF *SALMONELLA* SEROTYPES FROM COMMERCIAL FARM FEEDS. 1982-1986

Anette M. Durand

Several reports on antibiotic resistance in *Salmonella* have been published in recent years. The problem that arises is that organisms are increasingly isolated which exhibit multiple antibiotic resistance. This can be brought about by the presence of antibiotics in farm feeds, resulting in selection of antibiotic-resistant bacteria. These feeds may be involved in disseminating the resistant bacteria. To assess the situation in the Republic of South Africa on the resistance to antibiotics of *Salmonella* isolated from farm feeds registerable in terms of the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act 36 of 1947), as amended, an investigation seemed to be warranted. The aim of the investigation was to obtain a general picture of the present situation.

The results revealed that *Salmonella* usually showed resistance to penicillin, methicillin, erythromycin, tylosin, clindamycin as well as bacitracin, and to a lesser extent to streptomycin, tetracycline, neomycin, nitrofurantoin, gentamycin and konamycin.

The addition of antibiotics such as penicillin and the tetracyclines as growth promoters to animal feeds may create conditions for rapid selection of bacteria resistant to antibiotics. The use of antibiotics in the animal environment seems to increase the number of resistant bacteria in the environment. This may lead to the development of veterinary and human health problems depending on the possible transfer of antimicrobial resistance from animal pathogens to human pathogens or the spreading in the human population of animal pathogens resistant to antibiotics. These potential risks to public health brought about the use of antibiotics of economic value, but with little or no application as therapeutic agents in animals or man, as feed additives.

The elevated frequency of usually low levels of multiple resistance of *Salmonella* to the antibiotics suggests the availability of pools of bacteria which may be induced to transfer and/or increase their resistance to antibiotics depending on appropriate provocation (e.g. repeated exposure to therapeutically ineffective levels of certain antibiotics.)

The data emphasize the need for caution in the use of antibiotics, particularly in animal feeds. Extended surveying of, and epidemiological research on farm feeds, manufacturing mills and animal production units is essential.

ANIMAL FOODS

• Technology

OP.3221/52/1/1:

MEAT HYGIENE: PROTEOLYTIC PREPARATION OF MEAT FOR THE CULTURING OF AND TOXIN PRODUCTION BY *CLOSTRIDIUM* SPECIES. 1982-1986

Anette M. Durand

Work on this facet was terminated in September 1984, due to problems experienced with the culturing of the *Clostridium* spp. at the Food Hygiene Section of the Veterinary Research Institute. Problems were especially experienced with the upscaling of the facet by using larger volumes of culture for toxin production. It was not possible to use the larger fermenters at Vaccine Production and not feasible for the Food Hygiene Section to buy a large fermenter. Determination of toxin production was also hampered by a personnel shortage at both Sections.

In the light of the above-mentioned problems, it was decided to terminate the facet.

Toxicological investigations

TOXIC SUBSTANCES

• Toxicology

OP.3231/18/2/3:

THE EFFICACY OF ACETAMIDE IN THE PREVENTION AND TREATMENT OF EXPERIMENTALLY INDUCED GIFBLAAR POISONING IN SHEEP. 1984-1985

T.S. Kellerman

In this study the efficacy of activated charcoal and acetamide as antidotes against gifblaar poisoning was tested.

Although activated charcoal has been successfully used in the treatment of certain plant intoxications of livestock in South Africa, it was found to be ineffective in the case of gifblaar poisoning in guinea-pigs and in a sheep.

MFA is a relatively simple compound (FCH_2COOH) structurally resembling acetic acid (CH_3COOH). Its action is unique, since, contrary to most toxic substances, MFA is not detoxified *in vivo*, but is rather metabolised to a much more toxic compound, fluorocitric acid (FC). It is a strong inhibitor of the enzyme aconitase in the Krebs-cycle, which, by blocking this enzyme, causes impairment of cellular respiration and death. The latent period of MFA (or gifblaar) poisoning is the time needed for the conversion of MFA to FC. The mechanism of action of MFA (gifblaar) poisoning has been the subject of an intensive study during the last 3-4 decades to find an effective antidote.

Although, according to the literature, 400 compounds were tested, none was able to reverse the effect of FC. However, quite promising results for the prevention of poisoning in laboratory animals were obtained with compounds yielding acetate during their metabolism. These "acetate donors" can compete with MFA for the active site and when administered early enough (before exposure to MFA, but not later than in the early stage of latency) and in an excessive, but not toxic dose they are able to prevent FC formation, and thus the appearance of clinical signs. The best results were obtained with two compounds, glycerol monoacetate (monoacetin) and acetamide. While monoacetin is effective only by repeated intra-muscular injections, acetamide, being highly soluble in water, can readily be administered orally. For this reason acetamide was preferred as a treatment for sheep in our experiments.

Gifblaar leaves from one farm were dosed to sheep after their toxicity had been determined in guinea-pigs. Their LD_{100} was found to be 4,0 g/kg body mass and the effective dose of acetamide administered orally simultaneously with gifblaar in the prevention of lethal gifblaar poisoning was 2,5 g/kg body mass.

When 2,5-5 g/kg acetamide was dosed to sheep at various intervals before and sometimes after the administration of 5 g/kg gifblaar, 1 out of 5 survived compared with 0 out of 2 controls. Acetamide dosed at 2-3 g/kg, simultaneously with or after 2,5 g/kg gifblaar, could not prevent fatality (4 sheep). Dosing of 2 g/kg acetamide before and/or simultaneously with or after 1 g/kg gifblaar, prevented mortality : 10 out of 10 treated sheep survived *cf.* and 2 out of 7 controls.

Our experiments indicate that acetamide has some therapeutic value as antidote in the prevention of experimental gifblaar poisoning in sheep. Further investigations should determine the feasibility and applicability of our findings under field conditions in sheep and cattle.

Internal parasite investigations

HELMINTHS

• Pests

OP.3241/20/2/3:

HELMINTHS: IMMUNITY OF SHEEP AGAINST THE LARVAL STAGE OF *TAENIA MULTICEPS*. 1979-1985

A.J.M. Verster

Taenia multiceps is a tapeworm of carnivores and requires a ruminant as intermediate host in order to

complete its development. The larval stage, *Coenurus cerebralis*, occurs in the brain of its host, in the form of a cyst, containing numerous tapeworm scoleces ("heads"). The final host becomes infested when the cyst is ingested *per os*.

The infestation is economically most important in sheep, as losses among sheep can be considerable and goats and cattle are seldom infested. The condition, which can also affect humans, is found mainly in the Cape Province, and is very common in the Karoo and south-western OFS.

Methods

The research was aimed mainly at the stimulation of immunity in sheep to challenge with the parasite.

In 3 trials the development of *T. multiceps* in sheep, which were previously twice immunised with an Oncosphere Secretory Antigen (OSA), was compared to that in similar sheep, not previously immunised. The vaccine was produced by incubating oncospheres of the parasite in sterile medium, thereafter concentrating the medium. The amount of protein in the vaccine was not standardised.

About 40 days after the administration of the second dose of vaccine, the animals were challenged with 5 000-6 000 oncospheres ("ova") of *T. multiceps*.

In the third of the 3 trials it was also tested whether the immunity developed by the sheep was transferred passively from ewes to their lambs.

At slaughter the coenuri found were examined in order to ascertain whether the degree of development of the parasite differed from group to group.

Results

1 Vaccine

The results of the 3 trials are summarised in the following table:

With OSA			Without OSA	
Trial	Lambs (No.)	Positive	Lambs (No.)	Positive
Active immunisation				
1	3	0 %	3	100 %
2	30	10 %*	11	46 %*
3	85	5 %	42	52 %
Passive transfer of immunity				
4	24	54 %	-	-

*The development of the parasites in the few cysts found in the 3/30 "vaccine lambs", were delayed in development, compared to those in the 5/11 control, unvaccinated lambs.

2. Therapeutic treatment of infested sheep

It was found that the remedy, praziquantel, can be used to cure infested sheep. The remedy is too expensive, at the dosage rate required for recovery, for it to be used for routine treatment of animals in commercial herds, but it is very useful for treating very valuable stud animals, as well as for use as a research tool.

Conclusions

The vaccine certainly stimulates immunity in the sheep, but more work should be done to standardise the vaccine and also to determine the most effective vaccinating procedure. On the other hand, the production of the vaccine is still expensive at the moment, mainly because relatively little material is obtained from a dog and large scale production of a vaccine is impractical.

A line of investigation that may overcome the problems of antigen production, is the use of genetic engineering techniques. However, to date the Section has not done any research in this line, and it will take some time to develop. We also do not have anyone to take over this work at this stage, but we have offered the researcher as far as possible the use of our facilities which may be needed to continue the research at the Faculty of Veterinary Science, University of Pretoria.

• Pests

OP.3241/20/2/4:

HELMINTHS: INFESTATION OF GOATS WITH THE LARVAL STAGE OF
TAENIA MULTICEPS. 1971-1985

A.J.M. Verster

Taenia multiceps is a tapeworm of carnivores and requires a ruminant as intermediate host in order to complete its development. The larval stage, *Coenurus cerebralis*, occurs in the brain of its host, in the form of a cyst, containing numerous tapeworm scoleces ("heads"). The final host becomes infested when the cyst is ingested *per os*.

The infestation is economically most important in sheep, as losses among sheep can be considerable and goats and cattle are seldom infested. The condition, which can also affect humans, is found mainly in the Cape Province, and is very common in the Karoo and south-western OFS.

Methods

Two trials were conducted to determine the susceptibility of goats to different strains of *T. multiceps* and thereafter to compare goats and sheep as intermediate host of the different strains.

The strains used originated from the brain of a goat at Stellenbosch in Lebowa, the muscles of a goat in South West Africa/Namibia, and the brain of a sheep in the South Western Cape. Dogs were infested in the laboratory in order to have the various strains available for the trials.

The sheep and goats were infested with material originating from these dogs, and they were slaughtered when clinical signs were observed, or else 12-13 months after infestation if no clinical signs developed.

Results

In the first trial it was confirmed that goats are susceptible in the laboratory to infestation. Only the Lebowa and the S.W.A. strains of *T. multiceps* were used in this trial.

In the case of the Lebowa strain from the brain of a goat, 7/8 goats developed viable cysts in the brain, and 1/8 goats developed similar cysts in the muscles. In the S.W.A. strain, the corresponding figures were 6/7 and 1/7 goats.

The results of the second trial are summarised in the following table:

TABLE 1 - Susceptibility of sheep and goats to 3 strains of *Taenia multiceps*

Strain*	Goats			Sheep		
	Number	Brain +	Muscle +	Number	Brain +	Muscle +
Cape	10	30 %	0 %	9	40 %	0 %
Lebowa	9	0 %	0 %	10	10 %	0 %
S.W.A.	9	50 %	10 %	10	10 %	0 %

*Strains:
Cape - from the brain of a sheep
Lebowa - from the brain of a goat
S.W.A. - from the muscles of a goat

Conclusions

No marked differences occurred in these trials as regards susceptibility of sheep and goats, except that the goats in the second trial were more susceptible to the S.W.A. strain (from goats) than the sheep. It should be borne in mind, however, that no replicates of these trials were done, that only small numbers of viable cysts develop to maturity in individual animals, and that relatively large variations often occur in the development of the parasite. What was interesting, however, is the fact that goats were as susceptible as sheep to the strain of *T. multiceps* isolated from the brain of a sheep in the south-western Cape. And yet goats are seldom found infested in that region.

It is unknown why *T. multiceps* occurs only very rarely outside the Cape Province and the adjacent south-western OFS. To date the infestation has shown no signs of spreading to any extent to the rest of the country, but it may be advantageous to determine why this does not occur, as it may indicate a possible means of control of the disease in those areas in which it is prevalent. However, we do not have anyone

available to carry on with this work and it is requested that the facet be terminated.

The ultrastructure of the three strains of the parasite used in these investigations has not been investigated as suggested in one of the progress reports, because the strains of worms had been lost.

HELMINTHS

• Pests

OP.3241/20/4/1: HELMINTHS: ECONOMIC IMPORTANCE OF PARAFILARIOSIS OF
CATTLE. 1977-1985
I.H. Carmichael

Parafilariosis of cattle was first described in South Africa in 1964. Since then it has been found in numerous localities in the country, and it became obvious that it caused considerable economic losses. Consequently an extensive survey was conducted to determine the distribution and economic significance of the disease in the country.

Methods

This was primarily an abattoir survey of the lesions caused by infestation of cattle with the parasite, *Parafilaria bovicola*, that occurs in the subcutaneous tissues of cattle. The lesions are easily confused with those caused by bruising - to the extent that the condition is referred to as "false bruising".

During the course of the survey about 41 500 carcasses were examined at the following abattoirs: Pretoria (29 000), Johannesburg (3 000), Durban (3 000), Port Elizabeth (3 000) and Cape Town (4 000). Questionnaires were sent out for each consignment of cattle slaughtered during the survey. In the event of a producer not replying to the first questionnaire, a second or even a third was sent. The origin of the cattle was only taken as having been confirmed if the cattle had been on the farm of origin for at least 8 months immediately prior to marketing.

Results

Geographical distribution

The place of origin of about 30 % of the cattle was confirmed and these could be used for accurately determining the distribution of the disease in the country.

Parafilariosis is most common in Northern Transvaal (35,9 % of the cattle originating from this area), Northern Cape (13,5 %), and South-western Transvaal (12,2 %), and also in Natal (6,2 %), Western Free State (1,9 %), Eastern Free State (1,8 %), South-West Africa/Namibia (0,7 %) and in the Eastern Cape. In the areas of low prevalence the disease is apparently of little economic consequence, except for small localised spots.

The Mixed Sour Bushveld (41,3 %), Sour Bushveld (40,9 %), Thornveld (32,5 %) and Dry Sweet Bushveld (31,5 %) areas of Northern Transvaal are the most heavily infested. The disease is less prevalent in the Mopani Veld (11,1 %) and on the Pietersburg Plateau (14,3 %), with a dramatic reduction to 2,5 % in the Bankenveld (between Pretoria and Johannesburg) and 2 % in the True Grassveld areas. The disease is also common in Valley Bushveld areas, which confirms (as also shown in the survey) that it occurs along the main river valleys of the eastern coastal regions as far south as Port Elizabeth.

Climate

The critical factors that determine the distribution of the disease, are annual rainfall, and the interval between the first to the last frost (dependent, amongst others, on the altitude and the mean annual temperature).

Where the rainfall is less than 300 mm, no infestation is found; 17,4 % of carcasses in the 300-400 mm zone were infested, and 34,3 % in the 400-600 mm zone, whereafter the prevalence became reduced to 9,6 % at 800-1 000 mm and 0 % at >1 000 mm.

In regions where the period of frost is less than 120 days, the prevalence was 30,5 % but there was a dramatic drop to 1,6 % for a frost period >120 days.

In regions with a mean annual temperature under 17,5 °C, the prevalence was 7,1 %, but in warmer areas it was 32,4 %. Under 15 °C no infestations were seen and above 22,5 °C it also became reduced.

Optimum conditions for the occurrence of parafilariosis were therefore a rainfall of 400-700 mm, a frost period of less than 90 days, a mean temperature of 17,5-22,5 °C, and an altitude of 800-1 200 m.

Economic importance

Despite numerous claims to the contrary, there is no proof that the disease has spread at all in the country since it was first diagnosed in 1964. It may have become more intense in prevalence, but the survey showed that it occurs in all the areas that are climatologically suitable, and was not found to any extent outside these regions.

The losses caused by the infestation are due to trimming of affected meat from the carcass, and also to down-grading of carcasses (with resultant lowering of the price paid for the carcass), and sometimes also to total condemnation of carcasses.

While the prevalence of the disease was lower in the higher than in the lower grades, down-grading was more common in the higher grades. Although not proved, this higher prevalence in the lower grades theoretically implies that infested animals do not grow as well as those that are uninfested.

The infestation is therefore of great economic importance to farmers, but the use of anthelmintic remedies, that have become available since the survey, can reduce losses of slaughter stock to the minimum.

The effect of anthelmintics and dips on prevalence

Infestation rates in animals that originated from the Northern Transvaal and were treated routinely with thiabendazole and nitroxylin were significantly lower than in those that were treated with levamisole or trichlorfon. In the same area the prevalence in cattle regularly dipped in chlorinated hydrocarbon compounds was significantly lower than in animals dipped in organophosphates or carbamates. Furthermore, the frequency of use of chlorinated hydrocarbons in the summer months was inversely correlated with the prevalence of the disease.

These results suggest that the removal of the chlorinated hydrocarbon, DDT, from the market in the early 1960's may have led to an escalation in the intensity of the disease in the late 1960's.

Conclusions

This survey showed that abattoir surveys can be used very effectively for researching certain disease conditions, especially such as this, where most of the economic loss occurs as a result of trimming of affected meat at slaughter. It is, however, essential that the origin of all the animals used for determining the distribution of the disease condition be confirmed by means of questionnaires such as used in this survey, else the results are not trustworthy.

The survey showed indisputably that parafilariosis is economically of great importance in the country, but also that the alarmist reports from many persons and quarters concerned with the matter, that the condition was spreading in the country at a fast rate, were decidedly not warranted.

Reproduction investigations

INFERTILITY

• *Pathology*

OP.3251/19/2/1:

INFERTILITY: REDUCED DOSE VACCINATION OF ADULT CATTLE WITH *BRUCELLA ABORTUS* STRAIN 19. 1981-1986

S. Herr

The success of adult vaccination depends on 3 factors, namely

- (i) adult vaccination,
- (ii) short interval testing and
- (iii) the removal of reactors.

In one control herd the last 2 measures alone proved successful.

In adult vaccinated herds, a CFT titre of 392 IU₁/ml could be taken as indicative of infection for 2-4 months post-inoculation. From 6 months post-inoculation this titre would be 60 IU₁/ml or higher provided that this represented a four-fold or greater rise in titre.

Problems were experienced with persistent RBT reactions in 15-70 % of adult vaccinated animals for up to 23 months post-inoculation. This caused more work for laboratories in that every RBT positive case had to be subjected to the technically more exacting CFT test. In addition problems with the interpretation of titres were experienced for 12 months and longer after vaccination. This led, in practice, to a higher percentage of overkill in the herds.

The adult vaccination policy of the Directorate of Veterinary Services was revised on 86-02-05 (Dr P. Bosman 12/1/8/6/B) and this decision makes the investigation of the effects of adult vaccination of lesser priority. Any further investigation can be undertaken as part of project OP.3251/19, 1/2: Serodiagnostics of infertility, abortion and other diseases.

Entomological investigations

EXTERNAL PARASITES

• Pathology

OP.3261/19/1/5: THE INFLUENCE OF WEANING ON SERUM CONGLUTININ LEVELS OF CALVES AS WELL AS ON THEIR SUSCEPTIBILITY TO HEARTWATER.
1983-1986
J.L. du Plessis

The variation in the susceptibility to heartwater of cattle of different breeds and ages has been known for a long time. Young calves have an innate resistance independent of the immune status of their mothers, and adult cattle also vary markedly in their susceptibility to artificially induced heartwater. Previous investigations suggested that this variation may be related to the levels of conglutinin in their serum. It was therefore decided to more fully investigate the role played by conglutinin in the natural resistance of calves to heartwater.

Two groups of Bonsmara-cross bull calves were monitored for serum conglutinin levels from 3 months of age and weaned 2 weeks prior to being infected with *Cowdria ruminantium* at the age of 8 months and 12 months, respectively. The conglutinin titres of the year-old calves were inversely proportional to the severity of the reactions after infection. Severe reactions were observed and more than 50 % of the animals died from the infection. In contrast, reactions in the 8-month-old calves were mild to moderate and no correlation with conglutinin titres was found.

The interpretation of these results is that the non-specific resistance of cattle to heartwater consists of two components : a suckling-calf resistance which declines by 6-8 months of age and a conglutinin-mediated resistance which takes effect from about 5 months of age and persists life-long.

EXTERNAL PARASITES

• Pests

OP.3261/20/1/2: EXTERNAL PARASITES: TRANSMISSION OF *PARAFILARIA BOVICOLA* BY THE MUSCIDAE. 1972-1986
E.M. Nevill

Parafilaria bovicola lives under the skin of cattle and is the cause of slimy, bruise-like lesions on carcasses. Trimming, down-grading and condemnation can result in serious economic losses. In the live animal the female worm makes a hole to the outside and lays her eggs into the blood which drips from this hole.

Field studies in the Transvaal Bushveld led to the discovery of 3 vector flies, *Musca lusoria*, *Musca xanthomelas* and *Musca* sp. A. All 3 species belong to the subgenus *Eumusca* and only female flies were

infected in the field. They breed in cattle dung in the veld and feed on wounds and lachrymal secretions on cattle.

Of 20 375 flies collected and examined on Busveld farms, 64 % were vector flies and of these only 64 were infected.

Musca lusoria appears to play the major role in transmission as it is relatively abundant throughout the year with infected flies found between July and March. *Musca* sp. A. is only abundant from February to April but is important as a vector from February to May. *Musca xanthomelas* was never present in large numbers and was only infected from August to December when many infective blood spots were available. *Parafilaria bovicola* has probably not become established on the Highveld because of the lower temperatures which could limit vector numbers, especially during the critical spring period.

Laboratory studies showed *M. lusoria* to be larviparous and *M. xanthomelas* oviparous. Although the reproduction potential of *M. xanthomelas* is greater, *M. lusoria* is better equipped to survive.

Nearly 24 000 Bushveld cattle were examined for blood spots. Bleeding showed a seasonal periodicity with a peak in September. This seasonality is probably related to sunshine or rising atmospheric temperatures. The earliest blood spot in a calf was recorded 191 days after birth.

Bulls had the most blood spots followed by 1st-year oxen and heifers, then 2nd-year oxen and heifers. Very few breeding cows bled because immunity can possibly be related to high female hormone levels. Over 92 % of all blood spots were on the dorsal and lateral body regions and nearly 60 % on the shoulder and rib areas. The distribution of carcass lesions was fairly well correlated with the distribution of blood spots.

Experimental infection of *M. lusoria* and *M. xanthomelas* showed that *P. bovicola* could develop to the infective 3rd-stage larva and escape from the mouth-parts in both fly species. Development took place mainly in the fat-body cells of the abdomen and at 27 °C larvae took 9 days to reach the 3rd stage.

Cattle were artificially infected via the subcutis, the eyes, skin incisions, and intravenously (jugular vein) or when infected flies fed on wounds. For transmission to continue, female animals and oxen must be reinfected annually but bulls possibly only biennially.

The distributions of *M. lusoria* and *M. xanthomelas* were compared with the distribution of beef cattle and *P. bovicola*. *Musca lusoria* is distributed throughout the areas where beef cattle are raised. *Musca xanthomelas*, however, appears to be restricted to the northern half of the Republic above approximately 29 °S latitude. The reason for this restricted distribution is unknown.

Highly contagious diseases

HIGHLY CONTAGIOUS VIRUSES

• Pathology

OP.3281/19/2/2: HIGHLY CONTAGIOUS VIRUSES: PATHOGENICITY AND ANTIGENIC HETEROGENEITY OF NATURALLY OCCURRING AFRICAN SWINE FEVER VIRUSES. 1979-1985
G.R. Thomson

A fundamental question with regard to African swine fever (ASF) virus is the existence of immunologically distinct types or subtypes as well as the extent and location of the variability.

A non-haemadsorbing (NHD) virus of reduced virulence isolated from a field specimen which originated in Zaire was found to protect most (11/13) pigs against subsequent challenge with a virulent haemadsorbing (HD) strain (CV) but did not protect pigs against challenge with 7 other virulent HD strains. These viruses were used to attempt to identify the location of possibly important differences in the viral polypeptides and DNAs.

Comparison of the electrophoretic mobility of polypeptide immunoprecipitates of the different viruses in SDS polyacrylamide (SDS-PAGE) gels failed to identify any exploitable differences in the 25 specified polypeptides. It was therefore concluded that immunologically important differences were possibly too subtle to be identified by SDS-PAGE.

Subsequently, the DNA restriction endonuclease patterns of the different ASF isolates grown in pig alveolar macrophages labelled with ³²p were compared using Hind III and EcoRI. This showed, in contrast to the SDS-PAGE analysis, that there were considerable differences between the different isolates.

Because further work in this direction would require a large-scale effort incorporating techniques such as gene mapping and cloning, for which we are not equipped or experienced, this work was discontinued.

Molecular biological investigations

MACROMOLECULES

• Virology

OP.32/21/12/1/5: THE DEVELOPMENT OF IMMUNOCYTOCHEMICAL TECHNIQUES TO IDENTIFY VARIOUS VIRAL ANTIGENS IN TISSUE SECTIONS AS WELL AS CELL CULTURES ASSOCIATED WITH JAAGSIEKTE. 1984-1986

A. Payne

In this project a number of different antigens were investigated in jaagsiekte lung tissue sections as well as cell cultures using immunocytochemical techniques. This included jaagsiekte retrovirus (JSRV) antigen as detected by anti-Mason Pfizer retrovirus (MPMV) p27 serum and lentivirus antigen as detected by anti-smaedi-visna virus serum. An attempt was made to determine if the distribution of the viral antigens correlated with that of IgG, IgM, IgA and complement, as it had been demonstrated that JSRV purified from JS lungs, often existed as immune complexes.

Using the immune-blot technique it was confirmed that the South African lung wash material contained the MPMV related protein (JSRV p28). Although the MPMV related protein had been found in purified lung pellets it had not been shown unequivocally to be associated with JSRV particles. Immunocytochemistry using an anti-MPMV colloidal gold conjugate demonstrated that the JSRV p28 was indeed associated with viral particles. Similar results were obtained by staining of frozen lung sections with the anti-MPMV conjugate.

The antigen was always found in close association with tumour cells in the alveolar lumen and in some cases the apical section of the tumour cells appeared to be stained. Not all the lesions were producing the antigen and it was common to find a highly positive alveolar lumen adjacent to a completely negative one. By using an immunoperoxidase technique it was also possible to demonstrate sporadic JSRV antigen production in two JS tumour cell lines (15,4 and 21,3 cells).

A lentivirus has recently been isolated from jaagsiekte lungs. A double staining method confirmed that both JSRV and lentiviral antigens were produced in some jaagsiekte lungs. The lentivirus antigen appeared to be localised over the central part of the alveolar lumen whereas jaagsiekte retrovirus antigen is more closely associated with tumour cells. These results show that lentivirus antigen and jaagsiekte retroviral antigen can be produced simultaneously in a jaagsiekte lesion.

Sections of frozen jaagsiekte lungs were stained to localise immunoglobulin, complement and JSRV antigen in order to determine if there was any correlation between the distribution of JSRV antigen and that of immunoglobulin and complement. There appeared to be no clear correlation between the distribution of any of the immunoglobulins and that of JSRV antigen. There was however some IgA and IgG found in close proximity to the tumour cells in the same region as JSRV antigen. IgA appeared to be more widespread than the JSRV p28 antigen. There was very little IgM present. The distribution of complement, although overlapping to some extent with that of the JSRV antigen and immunoglobulins, was very different.

The immunocytochemistry results confirm the results obtained using EM. Immunocytochemical techniques are more convenient and more dependable than EM and are very important in distinguishing between the presence of the two retroviruses in our system. These results confirm that it is possible to detect both JSRV antigen (as detected by anti-MPMV serum) and lentivirus in the same lung. This is important because it indicates that in some JS lungs there is indeed lentivirus production and that the virus does not always remain latent in the macrophages. It was not possible to correlate the presence of immunoglobulin and JSRV antigen in frozen sections. This probably indicates that there is an excess of immunoglobulins in these lungs. However it should also be remembered that the antigen being detected does not appear to be a major JSRV antigen and different results could be obtained when antiserum against some of the other viral antigens becomes available.

AGRICULTURAL RESOURCE UTILISATION

RESOURCE RESEARCH

Primary resources

SOIL

- *Soil science*

- GB.5111/32/2/3: THE EFFECT OF NITRITE, BENZOIC AND A CINNAMIC ACID MIXTURES ON THE STIMULATION OR INHIBITION OF MICRO-ORGANISM POPULATIONS IN SOIL. 1981-1985
I.R. de Wet

The purpose of the research was to study the influence of nitrite, cinnamic and benzoic acid mixtures on the stimulation or inhibition of micro-organism populations in soil with the view to obtain more information on the occurrence of root diseases.

In the case of *Gaeumannomyces graminis* it was found that seringic, vanillic, sallistic, caffeic, o-cumaric and p-hydroxybenzoic acids and their mixtures with NaNO_2 stimulated its growth.

Cold water wheat straw extracts containing benzoic and cinnamic acids also stimulated the growth of fungi, bacteria, actinomyces as well as the root pathogens. A cold water extract of ashed wheat straw (490°C) to eliminate the cinnamic and benzoic acids on the other hand had no effect.

In the presence of NaNO_2 P-hydroxybenzoic acid had a larger inhibitory effect on Scheepers 69 wheat cultivar grown in pots than the other cinnamic and benzoic acids tested. The total mass of vegetative yield was reduced by 61 % compared to the control.

The cold water wheat straw extracts as well as the nitrite, cinnamic and benzoic acid mixtures resulted in the yellowing of the leaves of Scheepers 69. The number of ears was also reduced and the plants were stunted. The yellowing of leaves was not ascribed to a nitrogen deficiency or a negative nitrogen period as a result of the decomposition of the acids.

Fusarium graminearum in the presence of a cold water extract of wheat straw had the most pronounced inhibitory effect on the growth of Scheepers 69 in pots as compared to wheat straw extract alone or only the pathogen added to the soil. In the case of *Rhizoctonia solani* and *Gaeumannomyces graminis* only a very small inhibitory effect was obtained on the growth of Scheepers 69 in pots when they were added in the presence of cold water extracts of wheat straw.

In general it was found that nitrite always increased the inhibitory effect of cinnamic and benzoic acids on the growth of Scheepers 69 in pots.

Further research is not anticipated for the future.

WATER

- *Water requirements*

- GB.5112/31/1/3: EVALUATION AND IMPROVEMENT OF IRRIGATION MANAGEMENT IN THE LOSKOP IRRIGATION AREA. 1980-1984
A. Streutker

At the Loskop State Water Scheme waterlogging, drought and normal years occurred consecutively during 40 years of irrigation. Waterlogging was caused by bad water management on farms, leakage out of the total irrigation supply system and concentration of storm water. On the other hand water shortages were also caused by reduced water quotas and enlarged irrigated areas on farms. Unpredictable summer rainfall, reduced water quotas, intermittent water supply, and increasing pressure on the Department of Water Affairs to deliver more water resulted in neglect in early planning and a lack of skillful management of irrigation

water by farmers over the years. After 1978/79 (below average rainfall) and as a consequence of the installation of expensive centre-pivot irrigation systems, farmers and the Department of Water Affairs finally showed an interest in irrigation scheduling.

With the co-operation of Directorates and Institutes of the Department of Agriculture and Water Supply, the Department of Water Affairs concerned, Organised Agriculture, the Eastern Transvaal Co-operative and other agricultural companies, a technology transfer project was initiated in 1980. The aim was to evaluate existing irrigation management and to compare this management with scheduling by means of tensiometers, a class A-pan and an irrigation computer model. Leakages from canals, dams and furrows were also determined in order to introduce possible improvement in scheduling on commercial farms. Measurements of farm sluice water, irrigation application, soil water and crop yield were also taken on selected farms for three years whereafter the commercial application could be tested on additional farms during the dry spell of 1983/84.

Commercial water usage and yields of spring wheat, cotton, maize, soybeans and green peas were improved and gave results approaching those predicted by the water yield curve for each crop. The improvement could in general be ascribed to a reduced area being irrigated by the same amount of available water, and for wheat in particular, less water during the vegetative stage and more water during the reproductive stage of the crop. The response of farmers towards irrigation scheduling by means of tensiometers was positive but the effort needed to use the class A-pan procedure was found to be too great in relation to the yield increases obtained by improved water usage. The profile available water that could be extracted from the root zone in Hutton soils between two irrigations during the peak water use period for a high crop yield was between 40 mm and 70 mm only. The recently introduced concept of "profile available water capacity" was therefore not applicable to these soils. Ultimately about 100 of the 400 farmers used tensiometers for irrigation scheduling.

Water loss on farms, between the sluice and crop land, was between 4 % and 35 % of the total applied irrigation water. By means of a very intensive control system the Department of Water Affairs succeeded temporarily in decreasing the distribution losses on the right bank canal from 26 % to 20 %. Total canal losses are usually between 20 % and 40 %.

The *daily* monitoring of irrigation by technicians or farmers together with the keen interest of field officers and managers of agricultural co-operatives and companies formed the basis of the success of continued co-operation.

The results of this technology transfer project were locally introduced by means of farmer days, irrigation management days and popular articles in the local magazine of the Loskop Liaison Committee during the dry-spell years. Five scientific papers, three papers read at Irrigation Workshops and five popular publications also played an important role. Two projects funded by the Water Research Commission were extended by one year to include the proven technology transfer approach. During 1984 an identical WRC-funded project was initiated by the University of the North. Finally the approach to this project was acknowledged by the Work Session on Irrigation Research (Soil Science) in 1982 as the first step in technology transfer.

WATER

• *Soil science*

GB.5112/32/1/3: METHODS OF AMELIORATING THE ACID MINE WATER PROBLEM IN SOUTH AFRICA. 1979-1985
J.G. Thompson

Acid mine water resulting from the oxidation of pyrites are formed wherever gold and coal is extensively mined in South Africa. They contain free sulphuric acid together with varying amounts of iron and aluminium sulphates and collectively, on account of their huge volume, pose probably the greatest single problem that confronts the Department of Water Affairs in their administration of the Water Act with regard to water pollution control.

Although it was known that treatment involving neutralisation was required before discharge to streams, it was considered that further information on the range of acid waters in South Africa and the processes involved in their formation could indicate the most effective means of combatting the problem. Accordingly, a large number of acid mine water samples was collected covering a wide range of site conditions in both the coal and gold mining industries. These were analysed in detail and representative types

of acid mine waters were treated in various ways in the laboratory prior to further neutralisation experiments.

It was found that the development of acid mine waters involved three broad stages. The first two require aerobic conditions, one of which is accelerated by iron-oxidising bacteria, but the third and most acid-proceeding stage involves only an hydrolysis reaction that occurs with ageing even in the complete absence of oxygen. A slurry of slaked lime, i.e. calcium hydroxide, was found to be the most effective material for neutralisation and for reducing the salinity of strongly acid waters. From these findings, one obvious conclusion is that acid mine waters should be removed and neutralised as soon as possible from the acid generating zones in mines.

A further aspect that emerged from examining sites from which acid mine water samples were taken is that acid mine waters render all soils and soil-like materials much more pervious than in their original state and that in the process of percolating through such media at least partial neutralisation can in certain circumstances be achieved.

WATER

• *Soil science*

GB.5112/32/1/4: THE EFFECTIVENESS OF SOILS IN REDUCING WATER POLLUTION WHEN EFFLUENTS ARE DISPOSED OF ON LAND. 1979-1985
J.G. Thompson

On account of quality restrictions laid down by the Water Act, most effluents cannot be discharged to streams or underground water reserves. Since purification of effluents to meet the required quality standards is often prohibitively expensive, disposal on land becomes the only other alternative short of granting partial or complete exemption from the regulations. Since the Soil and Irrigation Research Institute acts as advisors to the Department of Water Affairs in their administration of the Water Act whenever disposal of effluent on land is practised, it was deemed necessary to investigate the effectiveness of soils in reducing water pollution by this means.

Effluents affect soils in different ways, depending on their composition, but the degree of effect of a particular effluent is often very much determined by the nature of the soil to which the effluent is applied. Effluents were therefore grouped into four main categories according to their likely effect on soils. These categories or groups are sewage effluents, ammoniacal effluents, organic matter rich effluents and alkaline sodic effluents, their likely effects on soils being progressively more deleterious or problematic. Excluding acid mine waters, these categories account for probably more than 97 % of effluents in terms of volume in South Africa.

Sites where disposal of effluents typical of these categories has been practised for varying lengths of time, were visited and a thorough examination made of the soils, the effluents and drainage waters if any. The results indicate that, as expected, sewage effluents are virtually harmless, to the extent that most soils can be used for their disposal. Calcareous and other highly base-saturated soils are among the most suitable soils for the ammoniacal and the organic matter rich effluents. At the other end of the scale, it is only the red sesquioxides, highly weathered soils that can be efficiently used on a sustained basis for the disposal of alkaline sodic effluents.

WATER

• *Soil science*

GB.5112/32/1/5: THE BENEFICIAL UTILISATION OF SLUDGE WASTES FROM WATER TREATMENT PROCESSES ON CERTAIN SOUTH AFRICAN SOILS THROUGH CROP PRODUCTION. 1982-1985
L. Champion

The study objective was to evaluate the effectiveness of sludge-P as compared to monocalcium phosphate (MCP) to supply P to a crop grown on a P-deficient sesquioxides soil, and to study the effect of large additions of sludge on certain soil P characteristics.

Italian rye grass (*Lolium multiflorum* var. Midmar) was grown in a depletion type pot experiment on two soils of the Griffin and Clovelly forms, with four levels of P application and from two sources (MCP and a municipal sludge). Eight harvests were taken where yield and various elements (both nutrients and potentially toxic elements) were monitored.

Response to increasing levels of P applied, from either source, was large but at each level the sludge treated soil out-yielded the MCP treated soil. P uptake from the sludge treated soils was higher in the Griffin soil but lower in the Clovelly soil, compared to the MCP treated soils. Relative efficiency of the sludge-P as compared to the MCP rose from 64 % to over 100 % in the Griffin soil and from 44 % to 87 % in the Clovelly soil. Metal concentrations were elevated in the herbage from both the sludge treated soils and were a source of concern.

Despite limitations imposed by the metal problem, sewage sludge performed well as a P fertiliser on these soils and could be regarded as a relatively cheap source of P for agriculture.

WATER

• *Agrohydrology*

V.5112/34/1/1:

WATER: SIMULTANEOUS INVESTIGATION OF FLOOD IRRIGATION, UNDER DRAINAGE AND CROP YIELDS ON A NUMBER OF FARMS IN THE VAALHARTS IRRIGATION AREA. 1980-1983

D.J. du Rand, G.H.I. Kruger and B.D.I. van Rensburg

Flood irrigation is almost exclusively practised on the Vaalharts Irrigation Scheme of 30 000 ha. The soils consist mainly of a fine sandy texture which is normally more suitable for sprinkler than for flood irrigation.

This study was conducted in the light of current and looming water shortages and inefficient irrigation practices that caused a rising water table and consequent drainage problems. The efficiency and the actual applications that are achieved with flood irrigation was determined. Furthermore, the Badenhorst equation used for determining the lay-out of flood irrigation systems was evaluated.

The results show that for the general lay-out used on the scheme, too little water was applied, rather than the expected excessive applications. The efficiency was generally high. In almost 50 % of all evaluations the application was sufficient and the efficiency was above 75 %. In only a few exceptional cases, too much water was applied. This indicated that flood irrigation as such, is not necessarily the reason for the high water table, and it can be implemented efficiently on these soils. The excess water, causing high water tables and a low efficiency, can be ascribed to other factors such as bad management, poorly designed systems and conveyance losses.

It was also found that the Badenhorst equation cannot be applied indiscriminately to determine the lay-out of a flood system. The lay-out has to be done according to empirically determined criteria. The equation can then be used to determine the irrigation stream size for a required application on the empirically determined lay-out.

Other unsolved managerial problems were identified. The most important being the measurement of stream size in a low pressure distribution pipeline, installed at a low cost and with a small head loss. A second problem is the regulation of a constant stream size from a storage dam with a varying head.

WATER

• *Modelling*

GB.5112/42/1/4:

SIMULATION OF THE WATER, SALT AND PLANT NUTRIENT REGIME IN CROPPED SOILS IN A LARGER AREA. 1983-1986

J.L. Hutson

Many studies are still undertaken to understand the interactive relationships between plants, soil, nutrients and the environment better. Mathematical modelling techniques provide the means to integrate these dynamic relationships in a meaningful way, with predictive abilities. During the last decade great progress has been made in the development of computer simulation models which has enabled research

workers to integrate some of their previously isolated areas of knowledge. The ready availability of such computer models is thus fast becoming a necessity in a number of research areas.

In this study mathematical models that were developed to simulate water and solute transport in soils were collected, studied and adapted to run on the Burroughs computer of the Department of Agriculture and Water Supply. They are all based on programs described in the literature, but have been modified to a greater or lesser extent. The programs are:

- (i) BURNS: A simple plate leaching model (Burns, 1974) which has been used successfully in both the UK and USA to simulate nitrate leaching in fallow soils. The data requirements are few and simple and it utilises easily-visualised concepts of water and salt movement in soil.
- (ii) HLDBK: The title is an abbreviation of "holdback", which is the phenomenon that Addiscott (1977) attempted to portray in this model of water and salt movement in structured soils. During and immediately after the application of water to structured soil, flow is assumed to occur only in larger cracks and macropores. Equilibration between the finer pores within peds or structural units and the larger pores occurs over a longer period of time. This gives rise to selective leaching of solute contained in large pores.
- (iii) LEACHM: A sophisticated finite difference diffusion-convection model based on that described by Tillotson, Robbins, Wagenet and Hanks (1980). This model treats soil and crop processes in as mechanistic a way as is feasible and includes much more detail of soil physical and chemical processes than the first two models.

The three models studied and collected as part of this facet represent three very different concepts of how water and solutes move through soil. The BURNS and HLDBK models are simplified in that they do not simulate processes which have an important bearing on and can in fact dominate solute composition and leaching. These processes include transpiration, interaction between solution and solid phases and microbiological transformation of the solute species. There are sub-routines in LEACHM for simulating these processes and these, or simplified versions, could be incorporated into the BURNS and HLDBK models when required.

Much effort still needs to be put into validation of these models in both laboratory and field. Although estimation or measurement of parameter values for a representative range of South African soils is necessary before the models can be used easily on a routine basis, there is no reason why they cannot be applied immediately in certain projects. Parameter estimation will involve a process of continual improvement and it is only by using the models that we will gain the insight and experience necessary for this task. Modelling and field work should proceed simultaneously and model sensitivity studies can be a useful guide to field monitoring and sampling strategies.

The models can be applied now to work involving:

- (i) prediction of quality and quantity of water draining from the root zone,
- (ii) leaching of plant nutrients especially nitrogen fertilisers,
- (iii) leaching of pesticides and herbicides, and
- (iv) the effects of spatial variability of soil properties on the root environment and the consequent variability of plant response.

Surveys and demarcation

WATER SURVEYS

• *Situation analysis*

D.5133/35/1/1: WATER RESOURCE SURVEYS IN THE DOHNE - BOLO TARGET AREA.
1980-1985
R.F.M. Childs

This report covers water resource surveys conducted on 9 farms totalling 3 782 ha situated in the Dohne-Bolo area of the Stutterheim Extension Ward.

The objective of the survey is to obtain water resource data which will play a role in the implementation of the Departmental policy of optimum resource utilisation at farm level.

The Dohne-Bolo area is characterised by an undulating topography with hill slopes varying from 6% to 10%. The geology is composed predominantly of dull yellow to reddish brown argillaceous sandstones and greenish grey mudstones of the Balfour formation. Exposed doleritic intrusions also occur throughout the area. The area experiences warm summers and mild winters and the mean annual precipitation varies between 550 mm-850 mm. This area is located predominantly in the Dohne Sourveld and the dominant species present are *Themeda triandra*, *Heteropogon contortus* and *Elionurus argenteus*. The condition of the natural grassland was found to be on the average, only 49% of the benchmark condition. This is mainly a pastoral area where most of the cultivated land is used for the production of forage crops.

Data was obtained from on-site investigations and from information supplied by the farmers. This data was recorded on inventory forms similar to those included in the report whereas the location and identification numbers of the water sources and water points were indicated on mosaics obtained from the local extension officer.

The results indicated that small stock dams (<2 250 kℓ) were the most popular form of harnessing and storing water. These dams were beginning to show signs of drying up owing to the limited rainfall, (135 mm) over the previous 6 months. It is evident from the survey that these dams cannot be relied upon in times of drought and that farmers should consider boreholes and/or larger storage facilities.

Most of the water analysed was found to be of a low to medium salinity (3,44-64,9 mSm/m) low sodium (0,61-8,0 SAR) nature. This factor and the existence of a number of potential dam sites indicate that expansion in the field of irrigation is a possibility which should be investigated.

LAND USE

• Situation analysis

D.5135/35/1/1:

A SURVEY FOR THE NATIONAL LAND USE INVENTORY IN THE
EASTERN CAPE REGION, 1982-1985

L.P.J. Swart

Because planners dealing with land use have been hampered in carrying out their task with confidence and accuracy through lack of information, the Department of Agriculture decided to carry out a National Land Use Inventory. A survey schedule was designed so that resulting information from the databank could be tested for at least 250 characteristics and in various combinations and permutations. It was recommended that the field work should be completed within a period of two years, and that surveyors should be agriculturists, conscientious, and responsible to ensure accuracy.

The survey was initiated in the Eastern Cape Region of the Department in November 1982, the field work starting in earnest in January 1983. The task was registered as a sub-project with fourteen facets, one for each extension ward in the Region. A responsible officer at each extension office was appointed. He was assisted in carrying out the survey by staff attached to his office, or drawn from other offices in the Subregion in which his office was situated. There were four Subregions in the Region.

It was the duty of the responsible officer to ensure that every survey unit was indicated on a trigonometrical survey map, scale 1:50 000, and that data in respect of every survey unit was recorded on the prescribed schedule. He was required to ensure the correctness of the work, and submit it to his Subregional office where it was certified correct before submission to Regional office for further processing.

The task of the Region was confined to the correction of the data and its submission to Datametrical Services in an acceptable form. The analysis of the results would be attended to by a special work group.

An officer to co-ordinate activities was appointed at Regional office. He, together with the subregional officers, supplied advice and guidance to each responsible officer and his co-operators at the Extension Ward offices during the field work.

While the survey was allocated high priority, activities of surveyors were affected by the necessity of attending to public demands owing to a severe drought situation, and the administration of the new Conservation of Agricultural Resources Act, 1983.

The field work was completed on 31 March 1985, and on 30 April 1985 the schedules had been checked by Regional Office Control ready for processing by data typists. A total of 8 061 survey schedules were completed covering an area of 6 907 489 ha. The survey units were demarcated on 130 trigonometrical survey maps, scale 1:50 000. Subregional and Extension Ward staff required 1 303 field and 2 204 office man-days of eight hours to complete the task.

Owing to lack of manpower to complete the task in the time allocated, detailed surveys could not be undertaken in certain densely populated areas such as peri-urban and irrigation schemes. The survey schedule data analysis will not allow the extraction of other information considered important such as number of full- or part-time farmers per specific area, number and classes of stock per farm in specific areas (such as per reasonably homogeneous farming area) and, through some misinterpretations of a question, the number of viable and non-viable farming units.

Nevertheless the data affords an important point of departure which will be a basis upon which to build, especially in respect of information which the agricultural extensionist needs very much.

RESOURCE UTILISATION RESEARCH (CROPS)

Field crops

SUMMER GRAIN

- *Potential studies*

D.5211/36/1/1:

THE ESTABLISHMENT OF MAIZE YIELD NORMS IN THE
STUTTERHEIM EXTENSION WARD. 1980-1984

P.G. King and B.I. Hill

The monitoring of maize yields on dry and irrigated land and the isolation of factors responsible for depressing yields were carried out in the Stutterheim Extension Ward of the Eastern Cape. During the period of the investigation mean yields of 5,6 and 3,8 tons of grain per ha were obtained on irrigated and dryland, respectively.

Low pH values which are associated with high soil aluminium levels and low soil calcium levels are responsible for depressing yields. Low plant populations and poor weed control were also responsible for low yields. Although these variables are highlighted, the investigation showed that high yields (in excess of 5 tons per ha) are associated with sound management practices regarding all aspects of maize production.

Garden crops

TUBER CROPS

- *Pests*

T.5221/20/1/1:

AN ECO-BIOLOGICAL STUDY OF THE BLACK MAIZE BEETLE
(*HETERONYCHUS ARATOR* F.) ON POTATOES. 1978-1986

C.H. Thornton

The distribution of *Heteronychus arator* (Fabricius) was found to coincide with those regions in South Africa experiencing a moderate climate.

A comparative morphological study was undertaken to distinguish all the stages of the life cycle of *H. arator* from the sympatric ruteline *Adoretus cribrus* (Harold) in order to prevent any confusion when monitoring black maize beetle populations.

During the five seasons from June 1981 to June 1986, *H. arator* populations were monitored on the farm Many Waters in the Middelburg district by means of soil sampling and light trapping. All life stages except the pupal stage were found to depths of approximately 25 cm in the soil. Pupae were located at about 1 m and deeper. The fluctuation in population numbers and life cycle of this beetle was determined by recording the number of eggs, larvae, pupae and adults recovered from soil samples.

Additional information was obtained by determining ovarian maturation and percentage of inseminated females throughout the season. The black maize beetle had one generation during a normal season and two

during a warm dry season. Various stages overwinter depending on the number of generations recorded during the previous season. The varying climatic conditions experienced each season caused the flight activity of *H. arator* to differ. Temperature played an important role in the initiation and termination of seasonal flight activity and flights were correlated with substantial rainfall.

TUBER CROPS

- *Pests*

T.5221/20/1/2:

A STUDY OF THE NATURAL ENEMIES OF *HETERONYCHUS ARATOR* (FABRICIUS). 1985-1986

C.H. Thornton

A study was undertaken during the 1985/86 season to establish which organisms could possibly be classified as natural enemies of the black maize beetle (*Heteronychus arator* F.) in the eastern Transvaal Highveld region. The aim of this study was to identify such organisms and to arrange them in sequence of importance with the prospect of using them in biological control programmes. Large numbers of *H. arator* individuals of all stages collected from the field were examined externally and internally for pathogens and parasites. Predators were identified by observation in the field and laboratory.

Parasitic nematodes formed the most important group of natural enemies and only parasitised a mere 0,55 % of the *H. arator* population. It thus seems that natural enemies do not play an important enough role in the biological control of the black maize beetle at present and hence cannot be considered for use in biological control programmes for the time being.

RESOURCE UTILISATION RESEARCH (ANIMALS)

Ruminants

LARGE STOCK

- *Reproduction*

V.5311/04/1/4:

LARGE STOCK: THE USE OF PRID FOR OESTRUS SYNCHRONISATION AND THE EFFECT ON FERTILITY OF BEEF COWS AT VAALHARTS. 1984-1986

J. Grobbelaar

Multiparous Afrikaner cows were treated with PRID (Abbott) (Group 1; n=40) or with PRID where the estradiol benzoate capsule was removed (Group 2; n=20) for a period of 12 days and inseminated 48 and 72 h after PRID withdrawal. Control cows (Group 3; n=30) were heat spotted for a period of 23 days and inseminated at oestrus and 12 h later. From 21 days after termination of the treatments the cows were exposed to fertile bulls until the end of the normal mating season.

Oestrus as a response to treatment was observed in 47,5 % of the cows in group 1 and 55 % of the cows in group 2. A calving percentage as a result to AI after PRID removal of 36,8 and 35,0 was recorded for groups 1 and 2, respectively. In group 3, 46,6 % of the cows were inseminated and calved. The total calving percentage for groups 1 and 2 was 50 and 45 %, respectively. Only 1 out of 9 cows with a condition score of 2,5 and lower conceived. Mean condition score for all the cows was 3,4.

PRID treatment of cows under extensive conditions will only be economically viable if high calving percentages can be realised. In this study the cost per calf born from synchronised oestrus and AI was R30,00, which offsets the advantages of PRID treatment, viz synchronised oestrus and insemination at set times.

SMALL STOCK

• Nutrition

- K.5312/05/4/1: UTILISATION OF DROUGH RESISTANT FODDER CROPS: A COMPARISON OF THE DIGESTIBILITY OF THREE *ATRIPLEX* SPECIES. 1976-1985
F.C. Hayward

Merino wethers were used to determine the voluntary intake and digestibility of three *Atriplex* species, viz *A. nummularia*, *A. canescens*, and *A. lentiformis*. Digestibility trials were conducted with freshly cut as well as with dried material of each species.

According to the results on digestibility of organic and dry matter, *A. nummularia* proved to be superior to the other two species and differs significantly ($P < 0.05$) both in the freshly cut and dried form. No significant differences occurred with respect to voluntary intake of dry matter.

SMALL STOCK

• Nutrition

- K. 5312/05/4/2: EFFECTS OF ENERGY SUPPLEMENTATION ON BODY MASS CHANGES OF MERINO EWES AND LAMBS GRAZING OLD-MAN SALT BUSH (*ATRIPLEX NUMMULARIA*) PASTURE. 1980-1985
F.C. Hayward

Lactating Merino ewes supplemented with either 0, 100, 200, 300, 400 or 500 g of alkali-ionophore-treated whole maize per ewe per day were kept on *Atriplex nummularia* pasture until the lambs were weaned at 120 days. Changes in body mass of ewes and lambs were recorded. No significant differences occurred in the body mass changes of the ewes although the slope of the linear regression flattened with less supplementation. The linear regressions of live mass of lambs reared by ewes receiving 500, 400 and 300 g supplementation, however, differed highly significantly ($P < 0.01$) from the control group. Supplementation of *A. nummularia* at a rate of approximately 300 g alkali-ionophore-treated maize per day seems to be indicated.

SMALL STOCK

• Nutrition

- K.5312/05/4/3: DETERMINATION OF THE OPTIMUM LEVEL OF ENERGY SUPPLEMENTATION TO PREGNANT ANGORA GOAT EWES GRAZING OLD-MAN SALT BUSH (*ATRIPLEX NUMMULARIA*) IN THE KAROO AND ARID REGIONS. 1984-1985
V. Gevers and P.D. Grobbelaar

Pregnant, adult Angora ewes, supplemented with either 0, 200, 400 or 600 g of alkali-ionophore-treated whole maize per ewe per day were kept on *Atriplex nummularia* pasture for the entire gestational period. Changes in live body mass, reproductive performance and various mohair traits were recorded. Live body mass gain during gestation was closely related to the amount of supplementation provided and highly significant differences ($P < 0.01$) occurred between all groups, except between the groups receiving 200 and 400 g alkali-ionophore-treated whole maize, respectively.

No significant differences in the recorded mohair traits occurred between the various groups. Although the results suggest that pregnant Angora ewes could maintain pregnancy on *A. nummularia* only, it is reasonable to assume that such animals run a relatively high risk of abortion especially during adverse weather conditions such as cold and wet spells. Supplementation of ewes on *A. nummularia* at a rate of approximately 300 g alkali-ionophore-treated whole maize per head per day seems to be indicated.

SMALL STOCK

• Nutrition

T.5312/05/3/1:

THE CHEMICAL COMPOSITION AND DIGESTIBILITY OF THE WHOLE MAIZE PLANT AND ITS COMPONENTS. 1982-1985

H.M.I. Schoonraad

Maize plants were collected at random from a 3-ha area and were separated into the components, grain, leaves, stem, cob-sheaths and cob. A sample representative of the whole plant was composited. Dry matter yields, component proportions, the chemical composition and *in vitro* organic matter digestibility of each component were determined.

The results indicated that the roughage fraction (leaves, stem, cob-sheaths and cob) comprised 50 % of the mass of the dry maize plant. The protein and mineral content of these components was low and the *in vitro* organic matter digestibility was only 53 %. Grain comprised the other 50 % of the dry plant mass and the organic matter digestibility was of the order of 86 %. The Ca content of this component (0.004 %) was below the requirements for animal production.

SMALL STOCK

• Nutrition

T.5312/05/3/2:

THE EFFECT OF DIFFERENT HARVESTING STAGES ON THE CHEMICAL COMPOSITION, DIGESTIBILITY AND DRY MATTER PRODUCTION OF THE MAIZE PLANT AND ITS COMPONENTS. 1982-1985

H.M.I. Schoonraad

The effect of weathering of the standing dry crop on yields and digestibility was studied. Samples comprising 10 maize plants collected at random were taken at monthly intervals on three successive occasions. The samples were separated into components.

There was little change in dry matter yield over the eight-week study period. Proportionately, masses of the grain and leaf fractions decreased ($P=0.05$), respectively, whereas masses of the stem and cob-sheath components increased ($P=0.01$). The *in vitro* organic matter digestibility of the leaf component decreased over the eight-week period ($P=0.05$). Yields in terms of digestible dry matter of the plant as a whole remained constant over the study period.

SMALL STOCK

• Nutrition

T.5312/05/3/3:

THE EFFECT OF NITROGEN FERTILISATION ON THE CHEMICAL COMPOSITION, DIGESTIBILITY AND DRY MATTER PRODUCTION OF THE MAIZE PLANT AND ITS COMPONENTS. 1982-1985

H.M.I. Schoonraad

The effect of fertilising with nitrogen on the yields and *in vitro* digestibility of the dry maize plant and its components was determined. Differential treatment comprised three levels of nitrogen application, 40, 120 and 200 kg N per ha. Samples comprising 12 randomly selected plants were taken in each treatment and were divided into components.

The results showed that under the conditions of the experiment the only benefit from nitrogen fertilisation was in respect of increases in *in vitro* organic matter digestibility of the grain ($P=0.01$) and leaves ($P=0.05$).

The effect of nitrogen fertilisation on *in vivo* digestibility of the roughage fraction of the maize plants was also determined. Roughage of maize plants which had been fertilised with 40, 120 and 200 kg N per ha

was fed to Dohne Merino wethers in digestion crates. Food residues, dung and urine were collected over a seven-day period.

Intake of dry matter, nitrogen and energy increased with increasing nitrogen level ($P=0,01$). The negative nitrogen balance of the roughage fraction at the 40 kg N per ha level was increased ($P=0,01$) to a positive balance with increasing nitrogen fertilisation owing to a decrease in the dung and urine nitrogen excretion expressed as a percentage of the nitrogen intake ($P=0,01$). Fertilising increased ($P=0,05$) the digestible and metabolisable energy content as well as the apparent nitrogen digestibility and dry matter digestibility.

SMALL STOCK

• Nutrition

T.5312/05/3/4:

THE EVALUATION OF THE MAIZE PLANT AS A COMPONENT OF A FINISHING RATION: 1982-1985

H.M.I. Schoonraad

The supplementation of a maize plant ration with protein and energy for the purpose of finishing lambs was investigated. Differential treatments comprised two levels of protein (11 and 14 %), two energy levels (12,5 and 13,7 MJ DE per kg) and three urea replacement levels (0, 16,6 and 33,3 % of the crude protein content on a nitrogen equivalent basis). A carcass control and a control treatment in which only maize plant ration without a supplement was fed, was included. Treatment groups comprised 10 lambs each and were slaughtered when the average live mass of the lambs within the group reached 42 kg.

Without supplementation the maize plant provided an inadequate ration for lambs. Supplementation with protein (regardless of the source) and energy resulted in improved animal performance. However, replacement of natural protein in rations with urea reduced the efficiency of food conversion, the growth rate and wool production.

SMALL STOCK

• Upgrading

K.5312/07/1/2:

COMPARISON OF DIFFERENT SELECTION METHODS IN MERINO SHEEP. 1962-1985

J.J. Olivier

Three selection groups of 200 Merino flock ewes each were maintained from 1962 to 1984 at the Carnarvon Experiment Farm. The three selection methods applied were as follows:

Group 1: Rams and ewes with the highest clean-fleece masses at two tooth were selected.

Group 2: Rams and ewes were selected by two experts according to the hand-and-eye method.

Group 3: Rams and ewes were selected at random (control group)

The selection differential for clean-fleece mass in Group 1 was 100 % better than that in Group 2. These results stress the fact that objective measurement is much more effective than subjective measurements for the selection of replacement animals.

The clean-fleece mass of each of the selected lines was calculated as the percentage deviation from the control line within years. Linear regressions were fitted on the data and were as follows:

Group 1: $Y = 7,01 + 0,19 x$

Group 2: $Y = -0,55 + 0,38 x$

The slopes of these two regressions differ non-significantly from each other and from zero. Insignificant response in clean-fleece mass was found in both Group 1 and Group 2. This was possibly due to a genotype x environmental interaction.

Non-ruminants

OTHER ANIMALS

- *Upgrading*

T.5323/07/1/1:

UP-GRADING OF THE NOOITGEDACHT HORSE. 1951-1986
G. Reid

In 1951 the Department of Agriculture brought a nucleus of Basuto type ponies primarily to save this pony from extinction and for the breeding of an indigenous farm and riding horse. A stallion named Vonk and 11 mares were obtained. Owing to large-scale inbreeding beforehand a Boer horse and a part-bred Arab stallion was also used, but to very limited extent.

In 1976 the Nooitgedacht pony was affiliated with the S.A. Stud Book Association and in 1977 all horses of the Department were sold to breeders by auction.

Because of the large-scale inbreeding at the onset it was decided to calculate the inbreeding coefficient of this breed.

Wrights formula, modified by Cruden and adapted in the Fortran IV computer program by Li and Roderick was decided on.

The 745 horses born before the end of 1977 gave a mean inbreeding coefficient, $F = 8,559 \times 10^{-2}$ (8,5 %), which is relatively low considering that some individuals had an inbreeding coefficient of up to 0,89, perhaps mainly owing to the extensive use of a number of immigrants. It also seems that fears of intensive inbreeding were unfounded.

The period after 1977 showed an average inbreeding coefficient of $1,103 \times 10^{-1}$ (11,03 %) for 1345 horses which is even higher than the first, but not enough to be of any great concern.

The mean inbreeding coefficient for the Nooitgedacht pony at the end of 1983 was 10,2 %.

RESOURCE UTILISATION RESEARCH (PASTURES)

Pasture

VELD

- *Chemical control*

K.5411/21, 1/1:

CHEMICAL CONTROL OF MESQUITE (*PROSOPIS* SPP.) IN THE
NORTH-WESTERN KAROO. 1977-1985
M. Vorster

On account of several representations and memorandums from farmers' associations on the menace of Mesquite in the North-western Karoo, as well as a survey on the extent of Mesquite invasion, it was decided to investigate some chemical-control methods on a limited scale. The main purpose of the exercise was to find the most economical chemical-control method, because the control of invader plants is an economic problem.

Since the extent and density of the Mesquite invasion did not warrant aerial spraying and that the cost of this treatment at that time was prohibitive, it was decided to concentrate mainly upon chemical control by means of stem treatments. Economic considerations also led to the use of a soil steriliser. Foliage spraying on seedlings was also conducted.

A randomised block design with three replications per treatment was used. The treatment were conducted during two seasons (*viz* spring and autumn) on two localities in the district of Kenhardt. The stem treatments were conducted on chopped seedlings, shrubs and trees.

The following herbicides, in different concentrations, were used, *viz* 2, 4, 5 - T, Tordon 155 and power paraffin and diesoline. Foliage spraying was done with Tordon 101 and Tordon 225 while Hyvar XG10 was

used as a soil steriliser.

As a result of the exorbitant price rises for petroleum products in 1979 it was decided to concentrate on low-volume foliage spraying with water-soluble herbicides.

Stem treatments on chopped seedlings as well as on shrubs (with a concentration of 5 ml/1 000 ml diesoline and higher) were 100 % successful in both seasons at both localities, while those on trees gave variable results. Foliage spraying on seedlings with Tordon 101 and Tordon 225 were 100 % successful. Hyvar XG10 was completely unsuccessful; this phenomenon can be ascribed to the low and variable rainfall of the area.

The application of ultra-low volume methods gave variable results. This can mainly be ascribed to the application techniques that were used.

It appears that foliage spraying with water soluble herbicides will be a more economical and convenient chemical-control method, especially when ultra-low volume application techniques are used. The latter can be applied more rapidly and with less effort, as it is not necessary to move through thickets or to creep under trees. The largest remaining problem consists in the actual application of the herbicide. Improved application techniques should therefore be investigated.

CULTIVATED PASTURE

• Potential studies

V.5413/36/1/1:

CULTIVATED PASTURES: EVALUATION OF *CENCHRUS CILIARIS* FOR BEEF PRODUCTION AT GLEN. 1978-1983

J.P. van Niekerk, H.O. de Waal, L.G. du Pisani, A.R. Blair, I.W. Knight and M. Knight

The objectives of this study were to identify possible shortcomings in the fodder flow from a dryland *Cenchrus ciliaris* pasture and the possible role of *C. ciliaris* as supplementation to veld. The trial was conducted on 31,5 ha *C. ciliaris* (cv. Molopo) pasture and 166 ha dry *Cymbopogon-Themeda* veld at Glen Research Institute.

Treatments consisted of 3 stocking rates on the *Cenchrus* pasture and 2 stocking rates on veld. Both the *Cenchrus* and veld were continuously grazed with reproducing cows. The five treatments were CL (*C. ciliaris* at 2 ha/LSU); CM (*C. ciliaris* at 1,5 ha/LSU); CS (*C. ciliaris* at 1 ha/LSU); VL (veld at 9 ha/LSU) and VS (veld at 6 ha/LSU.)

The *Cenchrus* pasture annually received 90 kg N/ha and also superphosphate (10,5 % P) to maintain the available P content of the soil at approximately 10 mg P/kg soil.

There was no indication that the 3 stocking rates applied to the *Cenchrus* pasture had an adverse effect on soil density (compaction). This tendency can probably be ascribed to the expanding characteristics of the clay soil when watered and the subsequent contraction when drying off.

Although rainfall distribution had a marked influence on the seasonal growth pattern of *Cenchrus ciliaris* it was obvious that this grass started producing actively in November, reached a peak production in February/March, whereafter production declined. Veld displayed a similar growth rhythm.

The seasonal DM production of ungrazed *Cenchrus* was respectively, 2,5; 3,3; 8,9; 4,8 and 0,9 ton/ha in 1978/79, 1979/80, 1980/81, 1981/82 and 1982/83. The mean DM production over the trial period (1978-1983) was 4,08 ton/ha. Ungrazed veld had a seasonal DM production of 0,96; 0,668; 1,73; 1,32 and 1,0 ton/ha, respectively with a mean production of 1,4 ton/ha over the five-year period.

Cenchrus ciliaris had a higher crude protein content and digestibility (on OM basis) than veld during active growth in summer. In the dormant season (winter) the differences were negligible. It is advised that *C. ciliaris* should be grazed in summer when its crude protein content and digestibility is most favourable, whereas veld is rested and grazed in winter. In the process the growth vigour of veld is promoted by resting in the active growing season.

Stocking rate had a marked influence on voluntary intake, available above-ground phytomass and the average daily gain (ADG) of the calves. All three parameters decreased with an increase in stocking rate on both *C. ciliaris* and veld. A stocking rate of 1,3 to 1,5 ha/LSU, under continuous grazing with a cow/calf production system, proved to be the optimum stocking rate for *C. ciliaris*. By comparing this result to the long-term grazing capacity of *Cymbopogon-Themeda* veld of 6 ha/LSU, it is evident that *C. ciliaris* can carry ca. 3,5 times more than veld.

CULTIVATED PASTURE

• Management

D.5413/41/1/5:

EVALUATION OF RHODES GRASS FOR BEEF PRODUCTION IN THE COASTAL REGION OF THE EASTERN CAPE. 1980-1984

T. Daines, R.A. Ingpen and R. Brummer

The production potential of Rhodes grass pastures established on old pineapple lands in the Alexandria-Bathurst area was determined in a stocking rate trial. Stocking rates used were 1 MLU/ha, 2 MLU/ha and 3 MLU/ha. The optimum stocking rate was calculated according to the method proposed by Jones and Sandland (1974) and the most profitable stocking rate was determined according to the method of Booyesen (1975). Results show that old pineapple lands, when established to Rhodes grass pastures, can be profitably used to grow out young steers when stocked at 1,78 MLU/ha.

The availability of pasture on offer and the ease with which it can be harvested has a direct effect on the performance of animals grazing the pasture. The tall lax growing pasture in the lightly stocked camps and the high allowance provided stock with unrestricted grazing and the opportunity to select the best diet. The fact that animal production failed to decline as the sward matured shows that the animals not only had adequate intake but were able to select a diet high in nutrients.

At the medium stocking rate animals were still supplied with adequate quantity but because of the greater pressure on the available feed they were forced to utilise less nutritious plant parts in satisfying their intake requirements. At the highest stocking rate no selection was possible; stock were forced to utilise all the herbage on offer and selection for plant parts and feed of a higher quality was not possible.

At the highest stocking rate there was also a distinct possibility that there was a shortfall in intake. The influence of availability on animal performance is well illustrated by the animal gains obtained in the trial. The gains per head were 137 kg, 105 kg and 39 kg, respectively, for the light, medium and high stocking rate treatments. In assessing the suitability of a pasture species for animal production it is important that the species must not only have a high animal production potential, but they must also exhibit sustained production under defoliation. Results show that Rhodes grass cannot withstand repeated heavy defoliation. This grazing resulted in a decline in the vigour of the pasture and an invasion of the pasture by grasses such as *Cynodon dactylon*.

The longevity of Rhodes grass pastures is dependent on the grazing management applied. Great care should be taken not to overutilise Rhodes grass if productivity is to be maintained. Grazing management strategies should promote dense ground canopies and periods of absence between grazings should be of sufficient length to promote the maximum production of quality dry matter. Rest periods should be between 50 and 60 days or the pasture should be grazed at the early flower stage, whichever occurs first.

If grazing management strategies and stocking rates are carefully controlled Rhodes grass pasture have a high animal production potential in the Bathurst-Alexandria area.

RESOURCE UTILISATION RESEARCH (FARMING SYSTEMS)

Farming enterprises

MIXED FARMING

• Management

D.5513/41/1/1:

THE COMPILATION OF A MANUAL TO PROMOTE MIXED FARMING PRODUCTION TECHNIQUES IN THE TSITSIKAMMA AREAS. 1983-1984

P.G. King

A farming manual was drawn up to serve as a guideline to farmers in the Tsitsikamma. Detail is given regarding the available resources as well as the enterprises which are adapted to the resources.

In the manual the production techniques for dairy, beef and mutton as well as short descriptions of vegetable, fruit and potato production are discussed. Pasture production techniques and economic aspects are also dealt with in detail.

MIXED FARMING

- *Management*

- D.5513/41/1/2: THE COMPILATION OF A MANUAL TO PROMOTE MIXED FARMING
PRODUCTION TECHNIQUES IN THE ALEXANDRIA AREA. 1984-1985
P.G. King

A farming manual was drawn up to serve as a guideline to farmers in the Alexandria coastal area. Detail is given regarding the available resources as well as the enterprises which are adapted to the resources.

In the manual the production techniques for dairy, wheat, chicory, maize and pasture production are discussed. Economic aspects are also dealt with in detail.

MIXED FARMING

- *Management*

- D.5513/41/1/4: THE COMPILATION OF A MANUAL TO PROMOTE MIXED FARMING
PRODUCTION TECHNIQUES IN THE QUEENSTOWN SWEET
THORNVELD. 1983-1984
P.G. King

A farming manual was drawn up to serve as a guideline to farmers in the Queenstown Sweet Thornveld. Detail is given regarding the available resources as well as the enterprises which are adapted to the resources.

In the manual the production techniques for woolled sheep, beef, Angora and Boer goats, Veld Managment and pasture production are discussed. Economic aspects are also dealt with in detail.

AGRICULTURAL PRODUCTION ECONOMY RESEARCH

Macro resource economy

STRUCTURAL STUDIES

- *Production economics*

- PE.5612/48/2/11: THE ECONOMIC FEASIBILITY OF SUNFLOWER OIL AS FUEL.
1983-1985
D. Armer

This study aimed to estimate the potential quantity and cost of sunflower-based fuel.

The Highveld Region, consisting of the Transvaal Highveld, Western Transvaal, the North-western and North-eastern Free State, is practically the only part of South Africa where increased sunflower production can logically occur. The production potential of these areas was determined in terms of yields and the maximum area that can technically be planted to sunflower. Some technical and economic problems restrain sunflower production.

Sunflower production is less profitable than that of this Region's main crops, maize and wheat. An increase in producer's prices, relative to those of other crops, will be necessary to stimulate production. Supply analysis was conducted to estimate producer's prices at which different quantities of sunflower would be produced. Regression analysis and linear programming were used in positive and normative supply functions.

A hypothetical calculation was done to determine final prices of sunflower fuel. The results of the

positive supply functions were utilised. It appears that derivation of fuel from sunflower oil will not be economically feasible. Problems can also arise with over-production of oilcake and glycerol.

STRUCTURAL STUDIES

• *Production economics*

PE.5612/48/3/3:

SUCCESS IN FARMING AND FINANCIAL RATIOS IN THE WESTERN TRANSVAAL GRAIN AREAS. 1983-1985

B.D.T. Janse van Rensburg

Financial ratios were calculated for 72 farmers over one production season and for 9 selected farmers over 5 years. Divergent results were obtained and many deviations occurred.

Low, and with some farmers, critically low profitability ratios were realised. From a solvability viewpoint, most farmers have few problems, although there are indications that assets have been overvalued.

Many farmers do have liquidity problems and some do not have sufficient funds to cover all their obligations. There are indications that many farmers have not used loan capital correctly. The majority use considerable short-term loan capital and the high interest rates on such credit are partially responsible for the poor liquidity of many farmers.

Over-expenditure and possibly, wastage of inputs, have probably contributed to the poor financial performance of some farmers. The drought since 1980/81 has also played a role in the deterioration of financial results in the region. Some farmers' financial results show a greater decline than those of others as a result of managerial deficiency.

Analysis of the 9 selected farmers over time shows inconsistent results in some cases; the coefficient of variation indicates a large degree of instability with reference to some of the ratios. Some farmers incurred unnecessary costs; for example fertiliser applications to maize have increased substantially to more than the gross revenue obtained. In an unstable production region like the Western Transvaal such a wastage of high cost resources can lead to financial disaster.

The results of the 9 selected farmers are more favourable than those for the rest of the sample, and suggests a better utilisation of resources. Thus it would be realistic to use their financial ratios as norms for the ordinary Western Transvaal farmer.

Significant relationships were found in farmers' performances in respect of the following groups of ratios: rate of return on own capital and nett farm income per hectare. Indications are that farmers who had poor results with these ratios were generally the worst off.

No significant relationship could be found between farm size and area under maize and those financial ratios which measure, *inter alia*, efficiency.

ENTREPRENEUR DEVELOPMENT

EXTENSION SCIENCE INVESTIGATIONS

Resources and technology

MANAGEMENT FACTORS

• *Conservation studies*

T.6114/38/1/3:

THE PERSUASION OF FARMERS TO OPTIMAL RESOURCE UTILISATION IN THE LOWVELD OF THE TRANSVAAL REGION (AVOCADO FARMERS - LETABA AREA). 1978-1983.
I.J. van Rensburg

Nature and scope of project

Apart from the above-mentioned long-term objective the project had the following short-term goals which were largely achieved.

- (a) To make a study of avocado production in the Letaba area by means of the Tzaneen Avocado Study Group and to apply the knowledge gained to the advantage of the avocado industry.
- (b) To annually assist at least ten beginner avocado farmers with the planning of their avocado orchards.
- (c) As determined by the time available and according to the requests received to pay as many visits as possible to farmers with specific avocado production problems (i.e. pest control, irrigation, fertilisation, etc).
- (d) To disseminate information by the use of mass-media, i.e. farmers days, agricultural weeklies, "Calling all farmers", pamphlets, local newspapers, etc.
- (e) To assist with the census survey of all avocado producers in Letaba area when necessary.

Results

A very broad spectrum of avocado production problems were attended to. These included the rootrot problem (*Phytophthora cinnamoni*), fertilisation, pest and disease control, nursery practices, etc.

The main thrust of the effort was, however, to try and reduce the incidence of rootrot in avocado orchards and this is the only aspect being reported so as not to make the report too lengthy.

In 1978 and in the years prior to this rootrot was a serious problem in orchards, causing a considerable loss in production and the pre-mature death of many trees. A survey indicated that 83% of all avocado orchards were to some extent affected by this disease. Many factors influence the occurrence of this disease but attention was mainly focussed on the following:

(a) *Chemical control*

The use of the chemical compounds *metaloxyl* and later *Fosatyl-al* was widely propagated and these compounds were used and tested on study group members' farms, even before they were registered. Demonstration plots were used, and in all cases the positive results achieved acted as a spur to surrounding farmers to make use of these methods.

(b) *Suitable soil*

Farmers were encouraged to avoid planting avocados on poorly drained and otherwise unsuitable soil by means of individual visits to farms, demonstration orchards and mini-farmers days. A total of 15 mini-farmers days were held during the five-year period.

(c) *Healthy nursery trees*

At all possible occasions farmers were motivated to buy only healthy and disease-free nursery trees on rootrot resistant rootstocks from registered nurseries.

Rootrot is not the dreaded disease it used to be in the late seventies and early eighties and in my opinion the above programme played its part in reducing the incidence of the disease to approximately less than 15 % of the avocado trees in the area.

RUN-OFF CONTROL

• *Agrohydrology*

T.6118/34/1/8:

THE DESIGN OF A RUN-OFF WATER CONTROL SYSTEM IN THE VLOOIKOP TARGET AREA, 1977-1979

C.F.R. Swart

A system was designed based upon and integrated with information on the natural resources to minimise soil erosion and uncontrolled run-off of surface water from individual farm units and between adjoining farms in the Vlooi kop target area. The aim was to ensure that run-off water followed the natural flow pattern of the catchment area as far as possible so that erosion could be kept to a minimum.

The Vlooi kop target area is situated in the Bronkhorstspuit magisterial district, between 28° 44' and 28° 52' E longitude and 25° 39' and 25° 44' S latitude and covers 13 476 ha. The target area is easily reached by tarred roads from Bronkhorstspuit to Groblersdal and from Bronkhorstspuit to Sybrandskraal.

The waterways were decided upon with the aid of a soil map and aerial photographs using a mirror stereoscope to determine the natural drainage flow. The proposed waterways were checked in the field and altered where necessary. This method enabled the hydrologist to place the waterways correctly with the minimum alterations and effort.

The waterways and distribution of soils, indicated on aerial photographs (scale 1:50 000), were transferred optically to a aerial photograph (scale 1:10 000).

According to the soil classification survey done by the Department of Agricultural Technical Services the high-potential agricultural soils are mainly comprised of Hutton and Clovelly forms which total 57 % of the area. The remaining 43 % consists of predominantly low-potential soils that occur as small isolated units in and adjacent to the natural drainage systems and marshes.

Water erosion is a substantial problem throughout the area on the high-potential soils. It is estimated that 162 km waterways and 1 352 km contour banks will be needed to conserve 5 747 ha of high-potential arable soils.

The general conclusion reached is that the implementation to the proposed waterways and contour banks is a long-term project of approximately 12 years. A possible solution to this problem would be to concentrate on smaller sub-areas.

BOTANY

BOTANY RESEARCH

Plant taxa

FLORA

• Taxonomy

PL.7111/01/1/4: FLORA OF SOUTHERN AFRICA: XYRIDACEAE, ERIOCAULACEAE, COMMELINACEAE, PONTEDERIACEAE AND JUNCACEAE. 1978-1985
A.A. Mauve

Nature and scope

A taxonomic revision of the monocotyledonous families Xyridaceae, Eriocaulaceae, Commelinaceae, Pontederiaceae and Juncaceae, covering indigenous and naturalised species, was completed and published as *Flora of Southern Africa* Vol. 4,2 (1985). Studies in Xyridaceae were made jointly with J. Lewis (United Kingdom) and in Commelinaceae jointly with R.B. Faden (United States of America); the rest of the work was done by the author.

Text drawings of each species were drawn by R. Holcroft, of the BRI. Enlargements of the seeds using the scanning electron microscope (SEM) were found to be useful for identifying species in *Xyris*, *Eriocaulon* and *Juncus*.

Results

The families studied were found to comprise the following numbers of taxa:

1. Xyridaceae, one genus, *Xyris*, with seven species in southern Africa;
2. Eriocaulaceae, two genera, *Eriocaulon*, with 12 species and *Syngonanthus*, with one species in southern Africa;
3. Juncaceae, three genera, *Juncus*, with 12 species, and *Prionium* and *Luzula*, each with one species in southern Africa;
4. Pontederiaceae, four genera, *Eichhornia*, with two species, and *Monochoria*, *Pontederia* and *Heteranthera*, each with one species in southern Africa.

FLORA

• Taxonomy

PL.7111/01/1/9: FLORA OF SOUTHERN AFRICA: LAMIACEAE. 1973-1986
G.E. Gibbs Russell

A taxonomic revision of Lamiaceae for the *Flora of Southern Africa* region, covering indigenous and naturalised species, was completed and published as *Flora of Southern Africa* Vol. 28, 4 (1985). With the exception of *Leonotis*, which was contributed by M. Iwarsson of Uppsala, Sweden, all the genera were written up by the responsible officer (L.E. Codd). Acknowledgement is due to the following authors whose recent published work on the genera indicated was largely accepted in the present study: I.C. Hedge, Edinburgh (*Salvia*, 1974), O. Sebald, Stuttgart (*Leucas*, 1978, 1980), and O. Ryding, Uppsala (*Aeollanthus*, 1981, 1982). With the exception of a few minor genera, black and white drawings accompany each genus. 40 of these were contributed by R. Holcroft of the Botanical Research Institute (BRI) and 3 were copied from Hedge's publication on *Salvia*, with his permission.

37 genera are recognised in southern Africa, with 232 species of which 217 are indigenous and 15 naturalised.

Since completing the presentation for the *Flora of Southern Africa* series, two further indigenous

species have been described and submitted for publication in *Bothalia*, namely: *Stachys comosa* Codd and *Thorncroftia media* Codd.

During the course of the study a new generic name, *Rabdosiella* Codd, and 41 new names (i.e. new combinations, new species, subspecies or varieties) were published.

FLORA

• Taxonomy

PL.7111/01/1/16: FLORA OF SOUTHERN AFRICA: BOTANICAL COLLECTORS. 1969-1985
G.E. Gibbs Russell

The study is a reference work covering the plant collectors active in southern Africa since the area was open to European exploration in the 1750's. About 3 400 individuals are covered, with biographical information provided for most of them. Portraits and examples of handwriting illustrate some of the most important collectors.

The book is a basic reference for taxonomists studying the southern African flora because of the importance of correct distribution information for the herbarium specimens that represent the naturally occurring species. In the case of earlier collectors, whose specimens are often particularly important for nomenclatural reasons, it can be difficult to establish localities precisely. The itineraries given for many of these early collectors result in great time-saving when determining localities for taxonomic studies that will result in treatments for the *Flora of Southern Africa*. The present whereabouts of the specimens for each collector is also extremely useful for taxonomic researchers, who must request loan specimens from a number of herbaria, in order to determine the range of variation of taxa and to obtain the type specimens for all scientific names.

ANGIOSPERMAE

• Anatomy

PL.7112/01/1/6: TAXONOMY OF ANGIOSPERMAE: THE ROLE OF FRUIT, SEED AND SEEDLING CHARACTERS IN THE CLASSIFICATION OF CUCURBITACEAE IN SOUTHERN AFRICA. 1983-1986
E. Retief

A morphological survey of the fruit, seed and seedling characters of the different genera and species of the family Cucurbitaceae, indigenous in southern Africa was undertaken. The family comprises 18 genera and 77 taxa. In order to become familiar with the different characters of the family, the different species were studied by means of specimens present in various herbaria.

Information on the collectors' labels of the species in the National Herbarium, Pretoria, was used to compile distribution maps and to check the flowering and fruiting times of the species in order to plan collecting trips undertaken in the R.S.A. and South West Africa/Namibia.

The external morphological characters of the seeds of 61 taxa were examined. The seeds differ mainly in size and shape. Some seeds are compressed, whereas others are tumid. The edge of the seed can have a prominent margin. The seeds are usually glabrous but hairy seeds do occur, for example, in *Coccinia* species.

The seed surfaces of a number of taxa were examined with the scanning electron microscope. The investigation showed that the surfaces and the cell structures do not vary significantly.

The fruits of 28 taxa were examined for their external morphological characters. The fruits are usually fleshy in nature. However, a dry capsule is found in *Gerrardanthus macrorrhizus*. In most species the fruit is a berry or pepo which is indehiscent. The species differ considerably in the size and shape of their fruits. The shape of the fruits vary from globose to ovoid and ellipsoid. The mature fruits have different colours when ripe, e.g. yellow, green and mottled, pink and red.

The fruit surfaces of 37 taxa were examined with the scanning electron microscope. The cells are in most cases, isodiametric but elongated cells are found in some species. On the basis of the curvature of the periclinal cell walls, the taxa can be divided into two groups, namely the periclinal cell walls of most taxa are concave with the anticlinal cell walls raised; the other group has convex periclinal cell walls. Various kinds of hair occur on the seed surface of some species, for example multicellular conical hairs, multicellular, uniseriate filiform hairs and glandular hairs with a multicellular head and stalk. Tubercles are present on the surface of certain species and also thick wax layers.

No investigation concerning the germination and the morphological characters of seedlings was undertaken.

A variety of morphological characters of the fruits and seed can be used for the classification of the different genera and species. Provisional keys where the different genera are keyed out in groups were compiled for the fruits and seeds of the family Cucurbitaceae on the basis of the morphological characters examined.

ANGIOSPERMAE

• Genetics

PL.7112/06/1/2: CYTOTAXONOMIC STUDIES OF ANGIOSPERMAE: THE CREATION OF A CYTODATABANK. 1977-1986
J.J. Spies

The project has two objects. Firstly, to create a cytodatabank in which cytogenetic information of South African plants can be collected and stored in such a way that it may be withdrawn selectively in various ways. This also entails collecting data from the literature. Secondly, it includes cytogenetic studies on indigenous plants in order to broaden our knowledge of South African plants in this respect.

An effective database was created, based on the VSAM disc system of IBM. Various selective withdrawal programs have been developed. These include programs for mapping chromosome number distribution, setting up karyo-types and tabulating chromosome numbers of taxa, accompanied by locality data and literature references. Provision is made for storing virtually any type of cytogenetic data on an individual plant basis. To date there are 4 449 entries in the databank.

Cytogenetic studies were done at two levels. Firstly, general surveys of different taxa were undertaken. Use was made of the living plant collections at the Botanical Research Institute in Pretoria, as well as plants collected in the veld. Cytogenetic information was gathered from approximately 66 such collections. In the general survey the success rate was generally in the region of 70 % of the plants collected mainly because of the fact that these collections included a wide range of taxa.

Secondly, more intensive studies were undertaken in a number of genera:

- (i) *Themeda triandra*. In all, 146 collections were studied; 53 collected all over South Africa, whereas the rest were population studies from the Pretoria area. Polyploidy levels of 2x, 4x, 5x, 6x and 10x were encountered. Generally, the polyploidy increases if one moves in from the south-east coast to the interior. The polyploids were found to be segmental allopolyploids and aposporic apomicts.
- (ii) *Eragrostis curvula* complex. A country-wide collection of 613 plants was studied. The following polyploid levels were found: 2x (1,3 %); 4x (42,6 %); 5x (8,2 %); 6x (35,6 %); 7x (8,29 %); 8x (4,4 %). In general, the levels of polyploidy increase from the Highveld to the coast - the opposite to that of *Themeda triandra*. The polyploids were all diplosporic apomicts, with a much higher rate of obligatory apomixis than *T. triandra*.
- (iii) *Streptocarpus*. Approximately 200 collections of 16 species of this genus were studied. All plants were diploids ($2n = 32 = 2x$). With the exception of three natural hybrids, their meiosis was regular.

The databank will be continued, but as a project of the University of Pretoria instead of the Botanical Research Institute.

Vegetation

FYNBOS

• Ecology

PL.7123/27/2/1: A PLANT ECOLOGICAL STUDY OF THE CAPE OF GOOD HOPE NATURE RESERVE. 1965-1985
H.C. Taylor

Environment

The Cape of Good Hope Nature Reserve, approximately 7 700 ha in extent, occupies the southern end

of the Cape Peninsula. It is roughly triangular with the two longer sides bounded by the sea, with altitudes ranging up to 360 m. The whole reserve is composed of level or gently inclined sandstone beds of the Table Mountain group of the Cape supergroup, resting on Cape granite which is visible only at the base of the Cape Point cliffs. Inland dunes, now stabilised, are a feature of the Reserve. They originated chiefly in sandy bays along the east coast and were blown inland in a north-westerly direction by the prevailing south-east summer winds.

A reconnaissance survey determined the distribution of soil types in relation to land form. In order to verify the field classification, 16 pre-selected type profiles were sampled by auger for chemical analysis. The dominant soil on the rocky hills and mountains is the Moeras series of the Mispah form, a shallow skeletal soil of *in situ* weathered and colluvial materials. On the lower slopes, deep coarse colluvial layers of the Fernwood Series are formed. The Cartref series, a leached, iron-free soil lacking a B horizon, is found in small, shallow, poorly drained depressions on the plateau. On sites where iron can accumulate, both on the plateau and in the larger stream valleys, ferruginised soils of the Witsand Series may develop. More strongly ferruginised soils of the Sandvlei Series are found on lower slopes near the basal shales of the Table Mountain group.

Soils developed on marine surfaces belong to the Mispah and Fernwood Forms. They are thus morphologically similar to the skeletal soils of rocky hills and to the deeper sand of lower slopes. The skeletal coast soils, however, although acid, are very close to base saturation, whereas the skeletal hill soils are base-unsaturated. The remaining coast soils are neutral or alkaline. On the whole, the correlation between soil, topography and vegetation is extremely good.

The Cape Peninsula, at a latitude of 34° South, possesses an equable, maritime, Mediterranean-type climate. In summer, the weather is warm and dry, with frequent strong south-easterly winds. About 90 % of the rain falls in winter. The gradual transition between summer and winter gives rise to prolonged spring and autumn seasons. The dominant climatic factor on the Reserve is wind. The strong, cool, moist south-east winds of summer combined with the effect of aspect, make the south-east slopes cool and moist. The mountain peaks around False Bay are often in cloud during "black" south-easters. The rain-bearing north-westerly winds of winter often have a "scorching" effect on the vegetation of the coastal shelf. Rainfall averages 700 mm per annum near the mountains in the north-east, but the Cape Point gauge records less than half this amount. The west coast is subject to fog at all seasons, but particularly during autumn.

During the present survey, only 10 % of the sampling sites on the Reserve, each 183 m radius, were completely free of alien plants. Between 1938 and 1965 the area was acquired by the Division Council of the Cape as a Nature Reserve. The Divisional Council aims eventually to re-establish the natural conditions prevailing at the time of the early settlers, while catering for the recreational needs of an increasing number of visitors. Undoubtedly the most serious and urgent problem facing the authorities is the eradication of alien vegetation, particularly the Australian *Acacia* species.

Vegetation

A descriptive account of the vegetation recognised two structural formations, Fynbos and Broad-leaved Thicket. Fynbos, a shrubby type of vegetation, occupies about 97 % of the area of the Reserve. Using floristic criteria, the Fynbos formation was subdivided into two alliances, Coast and Inland, which reflected the two major soil types present. The further subdivision into ten associations could be correlated firstly with edaphic factors, secondly with those physiographic factors which determine local climate, and thirdly with the effect of man's activities which result in the formation of secondary vegetation units. The Thicket formation is a simplified, floristically impoverished form of the coast forests of the Knysna region and was subdivided into two associations, namely *Sideroxylon* Thicket of the sandy coastal shelf, and *Maurocenia-Linociera* Tall Thicket of which remnants are found on the rocky screens and coastal escarpments protected from fire.

Statistical analysis

The method of association-analysis was developed on small areas of relatively simple vegetation, using many small quadrats closely and systematically spaced in a grid pattern. To make the method practicable for the extensive survey of large areas with a much richer flora, only 100 sample plots spaced systematically at 914 m were taken on the Cape of Good Hope Nature Reserve. Based on the results of a primary survey to determine plot size, rectangular plots of 5 x 10 m were used. In these 100 plots, 452 species were recorded. The association-analysis revealed 23 final groups. Only five groups showed high floristic and ecological homogeneity. Eight groups contained some anomalous, misplaced plots, while the remaining ten groups

represented small, isolated fragments of natural units. All groups except the five first-mentioned could not be readily interpreted in terms of habitat factors because each group included samples of vegetation with different ecological characteristics. In order to obtain a classification that accorded with habitat, these final groups could not be combined simply by raising the level of heterogeneity; instead, their constituent plots had to be re-grouped selectively on extrinsic characters of the habitat.

The advantage of association-analysis is that it produces a rapid objective classification that can be mapped. However, if the classification cannot be related to habitat without lengthy and complicated re-interpretation by someone with a detailed knowledge of the ecology of the area, the prime advantage of association analysis is nullified.

Phytosociological analysis

To provide an independent assessment of the association-analysis, synthesis tables were constructed from the original plot data using the revised techniques of the Continental phytosociologists. Plots were first grouped into three broad vegetation types (Coast, Moist Flats and Hillveld), then separate tables were drawn up for each type. Species occurring just outside the plots were included in the tables but given a different symbol. From the phytosociologist's viewpoint, the original data were faulty because sampling was systematic so that transitions between communities were blindly included. The data were also incomplete, because cover-abundance and sociability estimates for the species in each plot were not available. Despite these drawbacks, standardised manipulation of the tables revealed blocks of plots, represented by character species, which produced a better correlation with habitats than either the final or recombined association-analysis groups.

Conclusions

It appears that, at the level of sampling intensity used, the synthetic phytosociological method provides a more natural classification of fynbos communities of the Cape of Good Hope Nature Reserve than does the monothetic, subdivisive association-analysis method. For the extensive primary survey of fynbos on the scale envisaged, the delineation of practical, easily mapped vegetation units must be combined with speed in execution. It would seem that the well-tryed Zürich-Montpellier phytosociological methods, in the hands of skilled practitioners, hold greater promise for this type of survey in fynbos than association-analysis as tested in this study.

AQUATIC VEGETATION

• Ecology

PL.7126/27/1/1:

AQUATIC MACROPHYTE VEGETATION OF NATAL, 1974-1986
C.F. Musil

Nature and scope

Aquatic vegetation occurring in the marine, intertidal zone and in coastal and inland water bodies in Natal was surveyed. Data were synthesised and classified in a phytosociological table using PHYTOTAB, a computer-based classification procedure. Communities distinguished were ordinated using Detrended Correspondence Analysis (DECORANA) and presented in a synoptic table.

Specific results

Twenty-five water plant communities were distinguished in the phytosociological table. The floristic affinities between the various water plant communities as indicated from their relative positions (geometrical distances) in the ordination compared favourably with the sequence in which they were arranged in the phytosociological table. Four major groups of communities were distinguished related to water salinity (specific conductance), pH, elevation above sea-level and habitat, viz Brackish Water, Moderately Fresh Water, Moderately Fresh and Fresh Water and Fresh Water Communities. The first, second and fourth groups are possibly different associations, tentatively termed Euryhalinae, Mesohalinae and Oligohalinae,

with the third forming a transition between the Mesohalinae and Oligohalinae. Further surveys, however, will be required in other provinces of South Africa to establish whether these groups are natural or purely artificial and peculiar to the Natal Region.

NATURALISED VEGETATION

- *Ecology*

PL.7127/27/1/1:

NATURALISED VEGETATION: FIELD AND LABORATORY GROWTH OF *EICHHORNIA CRASSIPES* IN RELATION TO NITROGEN AND PHOSPHORUS LOADING. 1974-1986

C.F. Musil

Nature and scope

The kinetics of nitrogen (N) and phosphorus (P) limited growth of *Eichhornia crassipes* (water hyacinth) were investigated in greenhouse culture with the objective of developing a model for predicting population sizes, yields, growth rates and frequencies and amounts of harvest, under varying conditions of nutrient loading and climate, to control both nutrient inputs and excessive plant growth in eutrophied aquatic systems. The kinetic coefficients maximum specific growth rate (U_{max}), half saturation coefficient (K_s) and yield coefficient (Y_c) were measured under N and P limitation in replicated batch culture experiments. These coefficients were used in the Monod and Droop models to identify the limiting nutrient and to predict specific growth rates under conditions of varying water and plant nutrient concentration, respectively, and air temperature. Predicted data were validated by comparison with specific growth rates measured for plants growing in loosely and densely crowded populations at six field sites.

Specific results

The use of culture-derived U_{max} values in the models resulted in inaccurate predictive estimates of plant growth rates in loosely and densely crowded field populations. The use of field-derived U_{max} values in the models, however, resulted in fairly accurate predictive estimates of plant growth rates in loosely crowded field populations. The incorporation of radiant flux density and relative humidity into the models considerably improved their accuracy of prediction. In general, specific growth rates were more accurately predicted from the limiting nutrient concentrations in the water using the Monod model than from those in the plants using the Droop model. The application of the model in designing an effective harvesting strategy for water hyacinth, to control both nutrient inputs and excessive plant growth, is illustrated using nutrient loading and climatic data for the Vernon Hooper Dam at Nshongweni in Natal. The mechanical control measures currently being employed for these purposes in this impoundment were evaluated using the model. Predictive estimates of population sizes and frequencies and amounts of water hyacinth harvest required, to improve water quality and control excessive plant growth, in the impoundment compared favourably with those being employed.

AFRICAN VEGETATION

- *Ecology*

PL.7128/27/1/1:

AFRICAN VEGETATION: A PLANT ECOLOGICAL BIBLIOGRAPHY FOR SOUTHERN AFRICA UP TO 1975. 1982-1986

A.P. Backer

The Bibliography contains 4 242 references relating to a wide range of fields of importance to the understanding of natural vegetation in southern Africa. The regions covered include South Africa (and the TBVC countries), South West Africa/Namibia, Angola, Mozambique, Zimbabwe, Zambia, Malawi, Lesotho, Botswana and Swaziland.

The Bibliography is presented in three sections: the author index, the subject index and the thesaurus.

The author index runs alphabetically and chronologically and includes ecological references and vegetation maps up to 1975. The subject index is similarly arranged and is based on the Universal Decimal Classification (UDC) system using groupings of hierarchical UDC numbers as subject headings. The subject index consists of 8 sections namely Applied Ecology, Autecology, Environment Palaeoecology, Physiognomy, Reference Works and Maps, Synecology, and Vegetation Descriptions. Subjects that are of primary and secondary ecological importance have been covered in this bibliography. Subjects of tertiary importance (e.g. *Flora of Southern Africa*) have not necessarily been included.

The thesaurus is an alphabetical list of terms used for indexing each reference and is based on the Universal Decimal Classification system. Each term is cross-referenced hierarchically with broad and narrow terms, synonyms and related terms indicated. These terms were used as a basis for dividing the references into the eight subject sections.

The ecological bibliography for southern Africa forms part of the Ecology Division literature Index (EDLI) databank using the IBM System/370 computer. The IBM Storage and Information Retrieval System (STAIRS) programme package which is available for sorting and retrieving references, was used to sort the author index and sort and select references under various subject headings to form the subject index.

The ecological bibliography for southern Africa will meet an urgent need by researchers for a comprehensive bibliography. Considerable time will be saved at the start of projects where literature searching is often time-consuming. The current expansion of references in ecology, where other disciplines are often involved, makes a computerised databank for literature essential.

SCIENTIFIC ARTICLES
WETENSKAPLIKE ARTIKELS

PLANT PRODUCTION PROMOTION PLANTPRODUKSIEBEVORDERING

AGRONOMY RESEARCH AKKERBOUNAVORSING

Summer grain/Somergraan

MAIZE/MIELIES

- *Nutrition/Voeding*

- ADRIAANSE, F.G. & HUMAN, J.J., 1986. Die rol wat nitraat:ammoniumverhoudings speel in die effektiewe benutting van stikstof by *Zea mays* L. *Suid-Afrikaanse Tydskrif vir Plant en Grond* (3)2, 57-60.
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- FARINA, M.P.W. & CHANNON, P., 1986. The potassium nutrition of maize in Natal. *Proceedings of the Potassium Symposium*, Pretoria, 1-3 September 1985, 229-235.

- *Entomology/Entomologie*

- VAN RENSBURG, G.D.J., 1986. Entomologiese navorsing op somergraan met spesiale verwysing na plantbestandheid teen insekte. *Studiereisverslag*, VSA, 14-30 Maart 1986.
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- *Pests/Plae*

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- *Crop science/Gewaskunde*

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- FARINA, M.P.W. & CHANNON, P., 1987. Season and phosphorus age effects on the relationship between maize yield and phosphorus soil test on a highly weathered soil. *South African Journal of Plant and Soil* 4, 21-25.
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• *Soil Science/Grondkunde*

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• *Crop science/Gewaskunde*

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Small grain/Kleingraan

WHEAT/KORING

• *Pathology/Patologie*

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GROUNDNUTS/GRONDBONE

• *Nutrition/Voeding*

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• Crop science/Gewaskunde

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- BIRCH, E.B., VAN DER SANDT, J.C. & STRAUSS, F.M., 1986. The potential of basin tillage in sunflower production. *International Symposium on Agricultural Engineering* 2, 32-38.

SOYBEANS/SOJABONE

• Pests/Plae

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• Crop science/Gewaskunde

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TOBACCO/TABAK

• Nutrition/Voeding

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• Pests/Plae

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- *Technology/Tegnologie*

NEL, J.G. & WALL, C.R., 1987. Improving the fermentation ability of unripe air-cured tobacco. *South African Journal of Plant and Soil* 4, 51-52.

CHICORY/SIGOREI

- *Pathology/Patologie*

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HORTICULTURE RESEARCH/TUINBOUNAVORSING

Tuber crops/Knolgewasse

POTATOES/AARTAPPELS

- *Pathology/Patologie*

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- *Crop science/Gewaskunde*

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- *Crop science/Gewaskunde*

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- *Crop science/Gewaskunde*

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- *Water requirements/Waterbehoefte*

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- *Crop science/Gewaskunde*

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APPLES/APPELS

- *Physiology/Fisiologie*

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- *Pathology/Patologie*

- MANSVELT, E.L. & HATTINGH, M.J., 1986. Pear blossom blast in South Africa caused by *Pseudomonas syringae* pv. *syringae*. *Plant Pathology* 35, 337-343.
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- *Water requirements/Waterbehoefte*

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- *Pathology/Patologie*

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- *Pathology/Patologie*

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Viticulture/Wingerdbou

WINE GRAPES/WYNDRUIWE

- *Nutrition/Voeding*

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- *Management/Bestuur*

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WINE/WYN

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- *Nutrition/Voeding*

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- *Microbiology/Mikrobiologie*

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ANIMAL PRODUCTION PROMOTION DIEREPRODUKSIEBEVORDERING

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH DIEREPRODUKSIE- EN DIEREPRODUKTENAVORSING

Animal production/Diereproduksie

DAIRY CATTLE/MELKBEESTE

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- *Nutrition/Voeding*

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WOOLLED SHEEP/WOLSKAPE

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MEAT GOATS/VLEISBOKKE

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- *Management/Bestuur*

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Animal products/Diereprodukte

MEAT/VLEIS

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MILK/MELK

- *Microbiology/Mikrobiologie*

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ANIMALS/DIERE

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VETERINARY RESEARCH/VEEARTSENYKUNDIGE NAVORSING

Pathological investigations/Patologiese ondersoeke

PATHOLOGICAL INVESTIGATIONS/PATOLOGIESE ONDERSOEKE

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• Management/Bestuur

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ANIMAL FOODS/DIERLIKE VOEDSELS

• Pathology/Patologie

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- *Management/ Bestuur*

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TOXIC SUBSTANCES/TOKSIESE STOWWE

- *Toxicology/ Toksikologie*

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HELMINTHS/HELMINTE

- *Pathology/ Patologie*

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Reproduction investigations/Reproduksie-ondersoeke

INFERTILITY/ONVRUGBAARHEID

- *Pathology/ Patologie*

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EXTERNAL PARASITES/EKSTERNE PARASIETE

• Entomology/Entomologie

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RESOURCE UTILISATION RESEARCH (CROPS) HULPBRONBENUTTINGSNAVORSING (GEWASSE)

Field crops/Landgewasse

SUMMER GRAIN/SOMERGRAAN

- *Nutrition/Voeding*

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- *Pathology/Patologie*

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LARGE STOCK/GROOTVEE

- *Reproduction/Reproduksie*

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- *Nutrition/Voeding*

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PROJECTS/PROJEKTE

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AGRONOMY RESEARCH/AKKERBOUNAVORSING

Summer grain/Somergraan

MAIZE/MIELIES

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- GG.2111/31/2/4: The measurement of available soil water, root development, growth and production of maize on Hutton/Bainsvlei soils. 1985. R. Mottram

• *Modelling/Modellerling*

- GG.2111/42/1/1: The quantification of maize production risk. 1986. R. Mottram
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• *Physiology/Fisiologie*

- GG.2112/03/1/1: A physiological investigation of grain sorghum lines under moisture stress conditions. 1985. A.J. Pretorius

• *Upgrading/Veredeling*

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• *Pests/Plae*

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WHEAT/KORING

• *Physiology/Fisiologie*

- GG.2121/03/1/1: Determination of the temperature requirement of wheat. 1982. G.D. Joubert
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- GG.2121/03/1/3: Determination of morphological/physiological characteristics of drought tolerance of wheat. 1982. G.D. Joubert
- GG.2121/03/1/4: Determination of photosynthetic rate of wheat cultivars. 1983. G.D. Joubert
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- GG.2121/05/1/2: Effect of NP fertilisation on wheat under dryland conditions in the summer rainfall area at different soil and climatic situations. 1983. W.H. Kilian
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- GG.2121/19/2/2: Collection, maintenance and classification of wheat stem rust biotypes (*Puccinia graminis* f. sp. *tritici*). 1980. J. le Roux
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- GG.2121/20/1/3: Seed treatment with systemic insecticides for the chemical control of the Russian wheat aphid, *Diuraphis noxia*. 1980. P.A. Butts
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- GG.2121/20/2/2: Chemical control of false wire worm (Tenebrionidae) in wheat with soil and seed treatment. 1984. F. du Toit
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- GG.2121/20/3/2: Pathogenecity of eelworm species to wheat (glasshouse study). 1984. S. Storey
- GG.2121/20/4/1: The occurrence and distribution of foliar pests of wheat in South Africa. 1985. F. du Toit

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- GG.2121/30/4/1: The influence of soil cultivation methods on the production ability of soil with wheat in the summer rainfall region. 1982. H.A. Smit
- GG.2121/30/4/2: The influence of stubble mulching on grain yield of wheat in the summer rainfall area. 1982. H.A. Smit
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- GG.2121/30/5/1: The control of wild oats in wheat by means of a maize/wheat production system in the summer rainfall area. 1982. H.A. Smit
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- GG.2121/30/7/2: Phytotoxicity of broad-leaf herbicides on promising wheat lines and new wheat cultivars in the winter rainfall area. 1982. H.A. Smit
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- GG.2121/53/1/3: The identification of wheat cultivars by means of prolamine electrophoresis profiles. 1980. H.A. van Niekerk

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- GG.2122/07/1/1: The evaluation of elite newly developed and introduced cultivars. 1976. W.H.C. Struwig
- GG.2122/07/2/1: The selection of meiotic stable breeding parents from advanced triticale lines. 1976. W.H.C. Struwig
- GG.2122/07/3/1: The evaluation of triticale germ plasm. 1981. I.B.J. Smit
- GG.2122/07/3/2: The upkeep of unique triticale germ plasm. 1981. M. Streutker
- GG.2122/07/3/3: The development of a computerised database for unique triticale germ plasm. 1983. F.M. Thatcher

DURUM

• *Nutrition/Voeding*

- GG.2123/05/1/1: Effect of nitrogen fertilisation on the production and quality of durum wheat under irrigation. 1982. W.H. Kilian

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- GG.2123/07/1/1: The evaluation of elite newly developed and imported durum lines. 1976. H.A. van Niekerk
- GG.2123/07/2/1: The evaluation of durum germ plasm. 1981. I.B.J. Smit
- GG.2123/07/2/2: The upkeep of unique durum germ plasm. 1981. M. Streutker
- GG.2123/07/2/3: The development of a computerised database for durum production. 1983. F.M. Thatcher
- GG.2123/07/3/1: The quality evaluation of all newly developed durum lines. 1976. H.A. van Niekerk

BARLEY/GARS

• *Physiology/Fisiologie*

- GG.2124/03/1/1: Determination of factors which cause black-end coloration to barley in the winter rainfall area. 1982. E.J.G. Brand

• *Upgrading/Veredeling*

- GG.2124/07/1/1: The breeding of barley and evaluation of elite newly developed and imported cultivars. 1976. P.B. le Grange
- GG.2124/07/2/1: The evaluation of barley germ plasm. 1981. I.B.J. Smit
- GG.2124/07/2/2: The upkeep of unique barley germ plasm. 1981. M. Streutker
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- GG.2124/07/3/1: Quality evaluation of all new barley lines for brewing characteristics. 1976. H.A. van Niekerk

• *Crop science/Gewaskunde*

- GG.2124/30/1/1: Seed multiplication of elite barley lines and cultivars in the winter rainfall area. 1982. E.J.G. Brand
- GG.2124/30/1/2: Seed multiplication of the elite barley lines and cultivars in the summer rainfall area. 1982. G.D. Joubert
- GG.2124/30/2/1: Determination of the optimum planting date and sowing rate of barley cultivars in the winter rainfall area. 1983. E.J.G. Brand
- GG.2124/30/3/1: Leaf number/apex development stage relationship of barley in the winter rainfall area as influenced by chemical weedicides. 1982. H.A. Smit
- GG.2124/30/3/2: Phytotoxicity of wild oat herbicides on barley in the winter rainfall area. 1982. H.A. Smit
- GG.2124/30/3/3: Phytotoxicity of herbicides on promising barley lines and new barley cultivars in the summer rainfall area. 1982. H.A. Smit
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RYE/ROG

• *Upgrading/Veredeling*

- GG.2125/07/1/1: The evaluation of elite newly bred and imported rye lines. 1976. G.F. Marais
- GG.2125/07/2/1: The evaluation of germ plasm. 1981. I.B.J. Smit
- GG.2125/07/2/2: The upkeep of unique rye germ plasm. 1981. M. Streutker
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OATS/HAWER

• *Upgrading/Veredeling*

- GG.2126/07/1/1: The evaluation of elite newly developed oat lines and introductions. 1976. M. Streutker
- GG.2126/07/2/1: The evaluation of oat germ plasm. 1981. I.B.J. Smit

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Protein and oil seeds/Proteïen- en oliesade

GROUNDNUTS/GRONDBONE

• *Physiology/Fisiologie*

- GG.2131/03/2/1: The influence of varying temperatures on the gynophore and pod set of groundnuts. 1983. J. Dreyer
- GG.2131/03/3/1: Drying characteristics of groundnuts. 1983. C.J. Swanevelder

• *Nutrition/Voeding*

- GG.2131/05/1/1: NPK fertiliser studies with groundnuts. 1983. H.L. Loubser
- GG.2131/05/1/2: The influence of boron and calcium fertilisation on mould contamination of groundnuts. 1984. C.J. Swanevelder
- GG.2131/05/1/3: Calcium fertilisation of groundnuts. 1985. C.J. Swanevelder
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- GG.2131/05/1/5: Foliar application of seaweed extract on groundnuts. 1985. C.J. Swanevelder

• *Pathology/Patologie*

- GG.2131/19/1/1: Fusarium diseases of dryland cultivated groundnuts. 1985. S.H. Swart
- GG.2131/19/2/1: *Macrophomina* infections on groundnuts. 1985. E.L. Holtzhausen
- GG.2131/19/3/1: The influence of groundnut root and pod exudates on *Chalara elegans*. 1984. J.R. Anderson
- GG.2131/19/3/2: The influence of groundnut rhizosphere micro-organisms in controlling/stimulating *Chalara elegans* infestation. 1984. J.R. Anderson
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- GG.2131/19/3/4: Method of entry of *Chalara elegans* into groundnut tissue. 1984. J.R. Anderson
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- GG.2131/19/3/6: Laboratory studies on the nutritional requirements and biochemical pathways of *Chalara elegans* as found on groundnuts. 1984. J.R. Anderson

- GG.2131/19/3/7: Laboratory and greenhouse preliminary screens on groundnuts for biocides active against *Chalara elegans*. 1984. J.R. Anderson
- GG.2131/19/3/8: Developing of laboratory-greenhouse method for testing groundnut genotypes for resistance to *Chalara elegans*. 1983. B.L. Jones
- GG.2131/19/3/9: The use of crop rotations in controlling *Chalara elegans* in groundnuts. 1983. B.L. Jones
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- GG.2131/19/3/11: Biological control of *Chalara elegans* in groundnuts. 1982. J.R. Anderson
- GG.2131/19/3/12: Pathogenicity studies with *Chalara elegans* of groundnuts. 1982. C.L.E. Labuschagne
- GG.2131/19/3/13: To investigate the mode of *Chalara elegans* resistance in groundnuts. 1985. B.L. Jones

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- GG.2131/20/1/1: *Hilda patruelis* and mould on groundnuts. 1984. C.J. Swanevelder

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- GG.2131/30/2/2: Ridge planting of groundnuts for limiting black hull. 1982. J. Dreyer
- GG.2131/30/2/3: Harvesting techniques and mould contamination of groundnuts. 1985. C.J. Swanevelder
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- GG.2131/30/2/5: Basin tillage in groundnut production. 1984. E.B. Birch
- GG.2131/30/3/1: The influence of planting date on runner type groundnuts. 1985. C.J. Swanevelder
- GG.2131/30/4/1: Determining the effect of nut grass, *Cyperus* spp. on the yield of groundnuts. 1982. A.P.J. de Beer
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- GG.2131/30/5/1: The influence of mulching on mould contamination of groundnuts. 1984. C.J. Swanevelder
- GG.2131/30/8/1: Studies on spacing with newly released groundnut cultivars. 1985. C.J. Swanevelder

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• *Physiology/Fisiologie*

- GG.2132/03/1/1: Study on effect of environmental factors on growth, development and yield of sunflower. 1982. R.N. de Vos

• *Nutrition/Voeding*

- GG.2132/05/1/1: The nitrogen, phosphorus and potassium requirements of sunflowers. 1981. H.L. Loubser
- GG.2132/05/1/2: The response of sunflowers to different rates of nitrogen and phosphorus as influenced by liming. 1981. H.L. Loubser
- GG.2132/05/1/3: The evaluation of leaf analysis as a diagnostic technique in sunflower nutrition. 1981. H.L. Loubser
- GG.2132/05/1/4: The effect of mycorrhiza on the utilisation of phosphorus by sunflowers. 1985. H.L. Loubser

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- GG.2132/07/1/2: The breeding of sunflower restorer lines and composites for utilisation in hybrid breeding. 1974. B.C. Greyling
- GG.2132/07/1/3: The breeding of sunflower A/B lines and composites for utilisation in hybrid breeding. 1974. W.J. Vermeulen

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- GG.2132/19/1/1: *Macrophomina* infections of sunflower. 1985. E.L. Holtzhausen
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- GG.2132/30/2/6: Mulch period and level on sunflower production. 1985. E.B. Birch
- GG.2132/30/2/7: Millet mulching in sunflower production. 1985. E.B. Birch
- GG.2132/30/2/8: Mulch crops in sunflower production. 1985. E.B. Birch

- *Modelling/ Modellerling*

- GG.2132/42/1/1: Predicting of the effect of nitrogen fertilisation and moisture supply on the yield of sunflowers. 1985. H.L. Loubser

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- *Physiology/ Fisiologie*

- GG.2133/03/1/1: The effect of planting date on the response of soybean cultivars at different plant populations. 1983. J. Chapman
- GG.2133/03/1/2: Interaction between yield components and interplant competition of soybeans. 1985. M.A. Smit

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- *Nutrition/Voeding*

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- *Upgrading/Veredeling*

GG.2134/07/1/3: The breeding of dry beans for the packaging trade. 1983. B.R. Edington

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GG.2134/19/1/1: The production of disease-free dry bean (*Phaseolus vulgaris*) seed at Lutzville and Burgershall. 1977. A.J. Liebenberg

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- GG.2134/30/1/4: The evaluation of the International Bean Yield and Adaptation Nursery (IBYAN) of CIAT. 1983. A.J. Liebenberg
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• Physiology/Fisiologie

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- GG.2135/03/2/1: A survey on the occurrence of different alkaloids in lupin species and lines for the summer rainfall areas. 1985. J.A.M. van der Mey
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- GG.2135/05/1/3: Plant nutritional studies on lupins with macro-elements in the summer rainfall areas. 1985. H.L. Loubser
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• *Crop science/Gewaskunde*

GG.2136/30/1/1: Other seeds: introduction of cowpea breeding material. 1985. J.J. Coetzee

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Other agronomic crops/Ander akkerbougewasse

COTTON/KATOEN

• *Physiology/Fisiologie*

TK.2141/03/1/1: Investigation of possible causes of "rooidood" of cotton. 1983. N.J.J. Combrink

• *Nutrition/Voeding*

TK.2141/05/1/1: Response of cotton to nitrogen application with petiole analyses as diagnostic aid. 1980. M.C. Dippenaar

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- TK.2141/07/1/5: Determining the effect of certain morphological characteristics of cotton (*Gossypium hirsutum*) on insect infestations. 1985. H.G. van Heerden
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- TK.2141/07/2/2: National cotton cultivar trials. 1975. G.S.P. Vink
- TK.2141/07/2/3: Recovery of cotton breeding lines after a period of moisture or temperature stress. 1983. H.G. van Heerden

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- TK.2141/19/1/1: Occurrence of different races of *Xanthomonas malvacearum* on cotton in South Africa. 1983. R.J. van Wyk
- TK.2141/19/1/2: Pathogens associated with cotton seed and seedling diseases and its control. 1985. A. le Roux

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- TK.2141/20/1/3: The effect of nematocides on different nematode species and populations on cotton. 1985. M.S. Greeff
- TK.2141/20/1/4: The refinement of infra-red detection techniques (for remote sensing) to determine nematode infestation in cotton for improved management. 1985. M.S. Greeff
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- TK.2141/30/1/3: Practices for optimal utilisation of a short cotton growing season: the influence of plant density and row spacing on cotton cultivars with a short growing season. 1985. M.C. Dippenaar
- TK.2141/30/2/1: Chemical defoliation of cotton. 1982. M.C. Dippenaar

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- TK.2141/31/1/1: Influence of moisture deficits during different growth stages. 1977. M.C. Dippenaar
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• *Nutrition/Voeding*

- TK.2142/05/1/1: Nitrogen indices for and nitrogen supply of the Arcadia soil series for tobacco. 1972. C.J. Steenkamp
- TK.2142/05/1/2: Influence of different sources of nitrogen on the yield and quality of flue-cured tobacco. 1981. H.J. Boshoff
- TK.2142/05/1/3: Trace-element nutrition of tobacco. 1973. H.J. Boshoff
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- TK.2142/05/1/6: Potassium nutrition of tobacco. 1980. H.J. Boshoff
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- TK.2142/07/1/1: Determination of breeding value of flue-cured tobacco. 1964. H.G. van Heerden
- TK.2142/07/1/2: Determination of breeding value of dark air-cured tobacco. 1964. A. van der Spoel
- TK.2142/07/1/3: Determination of breeding value of light air-cured tobacco. 1967. A. van der Spoel
- TK.2142/07/1/4: Determination of breeding value of burley tobacco. 1969. A. van der Spoel
- TK.2142/07/1/5: Determination of breeding value of Oriental tobacco. 1969. A. van der Spoel
- TK.2142/07/1/6: Utilisation of haploid plants in tobacco breeding. 1976. A. van der Spoel
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- TK.2142/07/1/8: Breeding of *Nicotiana tabacum* cultivars resistant to diseases. 1952. H.G. van Heerden
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- TK.2142/19/3/1: The distribution of race and biotype of *Pseudomonas solanacearum* on tobacco. 1985. M.C. Engelbrecht
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- TK.2142/20/1/5: Influence of soil characteristics on the decomposition of carbofuran in tobacco cultivation. 1985. E.G. Eulitz
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- TK.2142/20/2/6: Susceptibility of rotation crops with tobacco and weed in tobacco lands for species and races of *Meloidogyne*. 1986. R.J. van Wyk
- TK.2142/20/2/7: The refinement of infra-red detection techniques (for remote sensing) to determine nematode infestation in tobacco for improved farm management. 1985. M.S. Greeff
- TK.2142/20/2/8: Survey of parasitic nematodes which occur in association with tobacco. 1986. M.S. Greeff

• *Chemical control/Chemiese beheer*

- TK.2142/21/1/1: Chemical weed control in flue-cured tobacco plantings. 1968. J.N. de Kock
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- TK.2142/30/1/1: Spacing and topping of flue-cured tobacco. 1966. F.J. Shawe
- TK.2142/30/1/2: Spacing and topping of dark air-cured tobacco. 1966. F.J. Shawe
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- TK.2142/30/1/6: Chemical control of suckers on tobacco. 1968. J.N. de Kock
- TK.2142/30/1/7: Cultivation of tobacco directly following wheat under irrigation. 1976. F.J. Shawe

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- TK.2142/31/1/1: Influence of flood and sprinkle irrigation on the yield and quality of flue-cured tobacco. 1968. F.J. Shawe
- TK.2142/31/1/2: Irrigation practices for establishment of seedlings. 1976. F.J. Shawe

• *Technology/Tegnologie*

- TK.2142/52/1/2: Yield losses in the field during reaping, curing and grading of flue-cured tobacco. 1979. J.G. Nel
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• *Chemistry/Chemie*

- TK.2142/53/1/1: Factors responsible for slick or putty tobacco. 1978. J.G. Nel
- TK.2142/53/1/2: Factors responsible for red-sponged tobacco. 1978. J.G. Nel
- TK.2142/53/1/3: Factors responsible for flat leaf and grain in flue-cured tobacco. 1981. J.G. Nel
- TK.2142/53/2/1: Determination of individual alkaloids in tobacco. 1981. J.G. Nel
- TK.2142/53/2/2: Nicotine status of flue-cured tobacco breeding lines. 1981. J.G. Nel
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- TK.2142/53/2/4: Physical and chemical characteristics of tobacco grades. 1978. J.G. Nel
- TK.2142/53/2/5: Phenolics, acids and volatile neutrals in tobacco leaf and their relationship to quality and aroma. 1985. C.R. Wall

SUNDRY AGRONOMIC CROPS/DIVERSE AKKERBOU GEWASSE

- *Crop science/Gewaskunde*

- GG.2143/30/1/1: Introduction of rice breeding material. 1980. J.J. Coetzee
GG.2143/30/1/2: Evaluation of cultivars for agricultural value and adaptability. 1980. J.J. Coetzee

CHICORY/SIGOREI

- *Nutrition/Voeding*

- D.2144/05/1/1: The fertilisation of chicory on an Oakleaf-Limpopo. 1981. R.S. Marr

- *Upgrading/Veredeling*

- D.2144/07/1/1: The selection of chicory. 1975. R.S. Marr

- *Pathology/Patologie*

- TK.2144/19/1/1: Determination of the causal organism(s) of blackrot in chicory. 1985. G.C. Prinsloo

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- TK.2144/20/1/1: Preliminary survey of parasitic nematode genera in chicory. 1985. R.J. van Wyk
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- D.2144/30/1/1: Chicory seed production. 1975. R.S. Marr
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HORTICULTURE RESEARCH/TUINBOUNAVORSING

Tuber crops/Knolgewasse

POTATOES/AARTAPPELS

- *Physiology/Fisiologie*

- TB.2411/03/1/1: The influence of calcium on the cell wall and cell structure of potato tubers. 1983. Marianne W. Venter
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- TB.2411/05/1/6: Influence of calcium on potatoes. 1984. M.W. Venter

• *Upgrading/Veredelings*

- TB.2411/07/1/2: Genetic studies in order to broaden the genetic base of potato breeding. 1974. A.F. Visser
- TB.2411/07/2/1: Anther culture as technique in the upgrading of potatoes. 1983. M.H. Crespo

• *Pathology/Patologie*

- TB.2411/19/1/2: Study and control of common scab of potatoes. 1978. B.W. Young
- TB.2411/19/1/4: Ecology and control of black scurf in potatoes. 1979. B.W. Young
- TB.2411/19/1/5: Control of silver scurf on potatoes. 1984. L. Marais
- TB.2411/19/1/6: Study of silver scurf on potatoes. 1985. L. Marais
- TB.2411/19/1/7: Control of anthracnose on potatoes. 1984. L. Marais
- TB.2411/19/1/8: Study of anthracnose on potatoes. 1985. L. Marais
- TB.2411/19/1/9: Study of *Fusarium* spp. concerned with dry rot and stem-end rot of potatoes. 1985. D.J. Theron
- TB.2411/19/2/1: Bacterial wilt on potatoes caused by *Pseudomonas solanacearum*: isolation of causal bacterium. 1984. A.E. Swanepoel
- TB.2411/19/2/2: Bacterial wilt of potatoes caused by *Pseudomonas solanacearum*: development of symptoms. 1984. A.E. Swanepoel
- TB.2411/19/3/3: Study of the aphid-virus complex and seed potato production. 1978. D.C.A. Hoffman
- TB.2411/19/3/6: Influence of potato virus X on different potato cultivars. 1980. D.C.A. Hoffman
- TB.2411/19/3/7: Potato virus Y in potatoes, identification and characterisation of strains. 1983. G.J. Thompson
- TB.2411/19/3/8: Potato leaf roll virus: purification procedures and anti-serum preparation. 1983. P.J. Prins

• *Pests/Plae*

- TB.2411/20/1/2: Bio-ecological study of the potato snout beetle. 1984. J.M.I. Donaldson
- TB.2411/20/1/4: A bio-ecological study of the black maize beetle *Heteronychus arator* on potatoes. 1984. J.M.I. Donaldson

• *Crop science/Gewaskunde*

- TB.2411/30/1/1: Potato cultivar evaluation in the Winter Rainfall Region. 1973. A. Agenbag
- TB.2411/30/1/3: Introduction and preliminary evaluation of foreign potato cultivars. 1973. A.F. Visser
- TB.2411/30/2/3: Sprout stimulants for breaking of tuber dormancy of potatoes. 1978. K.P. Prinsloo
- TB.2411/30/2/5: Influence of planting and fertilisation techniques on potato production at Glen. 1979. H.L.J. Potgieter
- TB.2411/30/2/7: The influence of tuber size and planting method on potato production at Sandvet. 1980. G.S. Cloete
- TB.2411/30/2/8: Methods to control volunteer potatoes. 1979. B.J. Pieterse

- TB.2411/30/2/9: The evaluation of defoliant for potatoes. 1979. G.J.J. Lubbe
- TB.2411/30/2/11: An investigation to the effective utilisation of seed potatoes. 1983. B.J. Pieterse

Vegetables/Groente

TOMATOES/TAMATIES

- *Upgrading/Veredeling*

- TB.2421/07/1/1: Breeding and selection of market tomatoes. 1975. S.E. Bosch
- TB.2421/07/1/2: Breeding and selection of processing tomatoes. 1975. S.E. Bosch

- *Pests/Plae*

- TB.2421/20/1/2: Bio-ecological studies of *Liriomyza trifolii* on tomatoes. 1985. M.C. Bolton

- *Crop science/Gewaskunde*

- TB.2421/30/1/1: Evaluation of new market tomato cultivars and breeding lines. 1975. H.A. Dafel
- TB.2421/30/1/2: Evaluation of processing tomato cultivars and breeding lines. 1975. H.A. Dafel

- *Water requirements/Waterbehoefies*

- TB.2421/31/1/1: Measurement of tomato leaf water potential. 1985. H.A. Dafel

ONIONS/UIE

- *Upgrading/Veredeling*

- TB.2422/07/1/1: Breeding and selection of onions. 1976. J.J.B. van Zijl
- TB.2422/07/1/2: The development of F₁-hybrid onions in South Africa. 1983. Elsa van der Klashorst

- *Pathology/Patologie*

- TB.2422/19/1/1: Studies of *Pyrenochaeta terrestris*, the pink root pathogen of onions. 1983. J.F. Ferreira

- *Crop science/Gewaskunde*

- TB.2422/30/1/1: Evaluation of onion cultivars and breeding lines. 1977. A.G. Comrie
- TB.2422/30/2/1: Influence of seed size and certain production practices on yield and quality of onions. 1984. A.G. Comrie

COLE CROPS/KOOLGEWASSE

- *Physiology/Fisiologie*

- TB.2423/03/1/1: The influence of seed treatments on the germination/physiology of cole crops: cabbage. 1984. B.H. Boelema

- *Pathology/Patologie*

- TB.2423/19/1/1: A study on the phenology, epidemiology and control of black leg (*Phoma lingam*) on cole crops: cabbage in Natal. 1984. B.H. Boelema

- *Crop science/Gewaskunde*

- TB.2423/30/1/1: Cole crops: evaluation of cabbage cultivars and breeding lines. 1976. P.J. Henrico
- TB.2423/30/1/3: Cole crops: evaluation of broccoli cultivars and breeding lines. 1981. W.P. Stapelberg

- *Water requirements/Waterbehoefes*

- TB.2423/31/1/1: Determination of the water requirements of cole crops: cabbage. 1982. P.F. Nortjé

ROOT CROP VEGETABLES/WORTELAGTIGE GROENTE

- *Upgrading/Veredeling*

- TB.2424/07/1/1: Root crop vegetables: breeding and selection of sweet potatoes. 1976. C.P. du Plooy

- *Crop science/Gewaskunde*

- TB.2424/30/1/1: Root crop vegetables: evaluation of sweet potato cultivars and breeding lines. 1976. C.P. du Plooy
- TB.2424/30/2/1: Root crop vegetables: the influence of spacing on sweet potato production. 1983. C.P. du Plooy

LEGUME VEGETABLES/PEULGROENTE

- *Physiology/Fisiologie*

- TB.2425/03/1/1: An evaluation of the efficiency of herbicides on green beans. 1981. P.F. Nortjé
- TB.2425/03/1/2: Evaluation of herbicides for phytotoxicity on green bean cultivars. 1981. P.F. Nortjé

- *Pathology/Patologie*

- TB.2425/19/1/2: Legume vegetables: a study of common blight of green beans. 1984. B.H. Boelema

- *Crop science/Gewaskunde*

- TB.2425/30/1/2: Legume vegetables: evaluation of green pea cultivars and breeding lines. 1976. Elsa van der Klashorst
- TB.2425/30/1/3: Legume vegetables: evaluation of dry pea cultivars and breeding lines. 1977. Elsa van der Klashorst
- TB.2425/30/2/1: Legume vegetables: plant density studies with green beans. 1977. A.F. Coertze

VINE CROPS/RANKGEWASSE

- *Physiology/Fisiologie*

- TB.2426/03/1/1: Weed control studies in pumpkin and squashes. 1982. P.F. Nortjé

- *Upgrading/Veredeling*

- TB.2426/07/1/1: Vine crop vegetables: breeding and selection of pumpkins. 1976. S.E. Bosch
- TB.2426/07/1/2: Vine crop vegetables: breeding and selection of muskmelon. 1976. Elsa van der Klashorst

- *Pathology/Patologie*

TB.2426/19/1/1: Virus diseases of vine crop vegetables. 1981. Francisca W. van der Meer

- *Crop science/Gewaskunde*

TB.2426/30/1/1: Vine crop vegetables: evaluation of pumpkin cultivars and breeding lines. 1977. Elsa van der Klashorst

SUNDRY VEGETABLES/DIVERSE GROENTE

- *Crop science/Gewaskunde*

TB.2427/30/1/2: Sundry vegetables: cultivation studies with lettuce. 1983. C.P. du Plooy

Flowers and ornamental plants/Blomme en sierplante

PROTEAS

- *Physiology/Fisiologie*

TB.2431/03/1/1: Prevention and control of physiological leaf browning of protea. 1984. J.A. Brink

- *Nutrition/Voeding*

TB.2431/05/1/1: Nutritional requirements of Proteas in sand culture. 1976. G.J. Brits

- *Updgrading/Veredeling*

TB.2431/07/1/2: Hybridisation studies with proteas: genus *Protea*. 1985. G.J. Brits

TB.2431/07/1/3: Mass selection for the upgrading of certain protea variants: genus *Protea*. 1985. G.J. Brits

TB.2431/07/1/4: Single plant selection for the development of new clonal cultivars of proteas. 1985. G.J. Brits

TB.2431/07/1/5: Hybridisation studies with proteas: genus *Leucospermum*. 1985. G.J. Brits

- *Crop science/Gewaskunde*

TB.2431/30/1/1: Collecting, maintaining and evaluation of protea research material. 1978. G.J. Brits

TB.2431/30/1/2: Evaluation of protea cultivars and selections. 1978. G.J. Brits

TB.2431/30/2/2: Reproduction of proteas by means of slips. 1978. G.J. Brits

TB.2431/30/3/1: Orchard cultivation practices of proteas. 1978. G.J. Brits

BULB FLOWER CROPS/BOLBLOMGEWASSE

- *Physiology/Fisiologie*

TB.2432/03/1/1: Embryo culture studies on bulb flower crops: *Gladiolus*. 1983. J.G.S. Janse van Rensburg

TB.2432/03/1/2: Embryo culture studies on bulb flower crops: *Ornithogalum*. 1984. Bela M. Veelaar

TB.2432/03/1/3: Rapid multiplication of bulb flower crops: *Ornithogalum maculatum* by means of tissue culture techniques. 1983. P.A. Landby

- TB.2432/03/1/4: Rapid multiplication of bulb flower crops, *Lachenalias* by means of tissue culture. 1982. J.G. Janse van Rensburg
- TB.2432/03/1/5: Rapid multiplication of bulb flower crops, *Gladiolus* by means of tissue culture. 1983. J.L.F. Dutrieux

• *Nutrition/Voeding*

- TB.2432/05/1/1: Nutrient requirement of indigenous bulb flowers. 1984. D.I. Ferreira

• *Upgrading/Veredeling*

- TB.2432/07/1/4: Sito-genetical studies of bulb flower crops: *Lachenalia*. 1984. F.C. Hancke

• *Pathology/Patologie*

- TB.2432/19/1/1: Identification of the virus diseases of certain bulb flower crops. 1975. J.T. Burger
- TB.2432/19/1/2: Virus elimination by means of chemotherapy and meristem culture in bulb flower crops: *Ornithogalum*. 1984. Bela M. Vcelar
- TB.2432/19/2/1: Bulb flower crops: study of *Uromyces transversalis* on *Gladiolus*. 1984. J.F. Ferreira
- TB.2432/19/2/2: Chemical control of *Uromyces transversalis* on bulb flower crops: *Gladiolus*. 1984. J.F. Ferreira
- TB.2432/19/2/3: Bulb flower crops: chemical control of *Uromyces transversalis* on *Gladiolus*. 1984. J.F. Ferreira

• *Crop science/Gewaskunde*

- TB.2432/30/1/2: Bulb flower crops: manipulation of flower and growth periods of *Lachenalias*. 1984. E. Badenhorst

CUT FLOWERS/SNYBLOMME

• *Pathology/Patologie*

- TB.2433/19/1/3: Cut flowers/pot plants: synthesis and cloning of a cDNA probe for *Chrysanthemum* stunt viroid. 1985. G.C. Bothma

• *Crop science/Gewaskunde*

- TB.2433/30/1/2: Cut flowers and pot plants: harvesting control of roses by means of pruning practices. 1983. D.I. Ferreira

Pome and stone fruits/Kern- en steenvrugte

APPLES/APPELS

• *Physiology/Fisiologie*

- VV.2441/03/2/3: A test for the occurrence of specific replant diseases of apples. 1982. H.J. van Zyl
- VV.2441/03/3/2: Chemical thinning of apples. 1985. A.F. Lourens
- VV.2441/03/4/2: Effect of different nitrogen sources on the utilisation of nitrogen fertilisers by apples. 1985. M. du Preez
- VV.2441/03/5/2: Starch granule counts as index of keeping quality and maturity of apples. 1985. P. van der Merwe

- VV.2441/03/6/4: An anatomical study of apple russetting. 1981. P. van der Merwe
- VV.2441/03/6/6: Uptake and translocation of silicon by the apple tree. 1982. J. Steenkamp
- VV.2441/03/6/7: The influence of nitrogen and potassium nutrition on the synthesis of organic acids and the incidence of bitterpit in apples. 1983. J.F. de Villiers
- VV.2441/03/6/8: A study of the muddy brown discoloration of Starkrimson apples. 1982. C.F. Hansmann
- VV.2441/03/6/10: The mechanism of action of rest-breaking agents in apples. 1986. M.S. North
- VV.2441/03/6/11: Control of delayed foliation of apples. 1986. M.S. North
- VV.2441/03/6/12: Optimisation of diphenylamine treatment of apples for control of superficial scald. 1988. G.J. Eksteen
- VV.2441/03/6/13: Stem en russetting of apples. 1986. J. Steenkamp

● *Nutrition/Voeding*

- VV.2441/05/1/4: Mapping of FFTRI Experiment Farm apple orchard soils. 1975. J. Wooldridge
- VV.2441/05/1/5: Determination of the lime requirement of apple orchard soils and the mobility of surface-applied lime in soils. 1984. J.M. le Roux
- VV.2441/05/1/6: Investigation and revision of methods of chemical analysis of soil and plant samples from apple orchards. 1984. M. Conradie
- VV.2441/05/2/5: Effect of seaweed leaf sprays on nutrient uptake by and fruit quality of apple trees. 1981. J.F. de Villiers
- VV.2441/05/2/6: Seasonal distribution of nitrogen and potassium fertilisation for apple trees. 1985. M. du Preez
- VV.2441/05/2/7: Effect of nitrogen potassium and phosphate fertilisation practices on the fruit quality of apples. 1985. M. du Preez

● *Upgrading/Veredeling*

- VV.2441/07/1/2: Breeding of apple cultivars resistant to scab. 1977. J.H. Acker
- VV.2441/07/1/3: Breeding of late red apple cultivars. 1977. J.H. Acker
- VV.2441/07/1/5: Breeding of apple cultivars with a compact growth habit. 1977. J.H. Acker
- VV.2441/07/1/6: Mutation breeding *in vitro* of Granny Smith apple to develop a compact growth habit. 1985. R.E. Pieterse
- VV.2441/07/1/7: Development of Granny Smith apple plants from callus and single cells for use in mutation breeding. 1985. R.E. Pieterse

● *Pathology/Patologie*

- VV.2441/19/1/2: Investigation of curative and protective characteristics of existing and new fungicides for apple scab control. 1981. W.F.S. Schwabe
- VV.2441/19/1/3: Studies concerning requirements for apple fruit infection by *Venturia inaequalis*. 1981. W.F.S. Schwabe
- VV.2441/19/1/4: Implementation of an apple scab warning service. 1981. W.F.S. Schwabe
- VV.2441/19/1/6: Isolation techniques for collar and root rot pathogens of apples. 1985. W.A. Smit
- VV.2441/19/1/7: Control of core rot in Starking apples. 1983. J.C. Combrink
- VV.2441/19/1/8: Bacterial blister spot of apples. 1983. E.L. Mansvelt
- VV.2441/19/1/9: Evaluation of wound protectants on apples. 1986. M. Nicholson

● *Pests/Plae*

- VV.2441/20/1/1: Radiation sterilisation of the infesting stages of fruit flies. 1972. B.N. Barnes

- VV.2441/20/2/1: Bionomics of snout beetles on apples. 1981. B.N. Barnes
- VV.2441/20/2/2: Monitoring systems for pest mites and a mite predatory beetle on apples. 1981. K.L. Pringle
- VV.2441/20/2/3: Bionomics of codling moth on apples. 1982. T.L. Blomefield
- VV.2441/20/2/4: Selective pesticides for the mite predatory beetle on apples. 1985. K.L. Pringle
- VV.2441/20/3/1: Survey of the different nematode species occurring in Western Cape apple orchards. 1979. H.J. Hugo
- VV.2441/20/3/2: Chemical control of nematodes attacking apple trees. 1980. H.J. Hugo

• *Crop science/Gewaskunde*

- VV.2441/30/1/1: The planting and maintenance of apple cultivars. 1972. J.V. Hadlow
- VV.2441/30/1/2: Second phase evaluation of apple cultivars in the Western Cape. 1971. P.R. Jolly
- VV.2441/30/1/4: Evaluation of Golden Delicious apple types. 1979. P.R. Jolly
- VV.2441/30/3/2: The pruning of close-planted apples. 1972. O. Bergh
- VV.2441/30/3/3: Training systems for apples on dwarfing rootstocks. 1972. O. Bergh
- VV.2441/30/4/1: Fruit size in apples. 1971. O. Bergh
- VV.2441/30/6/2: Effect of grass and leguminous cover crops on the performance of apple trees. 1986. R.E. Harris

• *Water requirements/Waterbehoefies*

- VV.2441/31/1/2: Effect of irrigation scheduling and soil moisture regime on the yield and quality of apples. 1985. W.A.G. Kotzé
- VV.2441/31/1/3: Effect of irrigation system, irrigation schedule and soil management on root development of apple tree and utilisation of applied water. 1985. J.H.M. Karsten

• *Meteorology/Weerkunde*

- VV.2441/33/1/1: Overhead cooling of apples. 1979. W.A.G. Kotzé
- VV.2441/33/1/2: Development of a model for the calculation of the optimum date of application of rest-breaking materials. 1986. M.S. North

• *Technology/Tegnologie*

- VV.2441/52/1/1: Influence of gas composition during controlled atmosphere storage on the keeping quality of apples. 1978. A.B. Truter
- VV.2441/52/1/3: Effect and rate of re-cooling and atmosphere modification on apple quality. 1984. G.J. Eksteen

• *Chemistry/Chemie*

- VV.2441/53/1/1: Development of an objective index for quality of apple juice based on the flavour components of apples. 1982. C.A.R. Hurt
- VV.2441/53/1/2: Quantitative chemical analysis of apples by means of the scanning electron microscope and energy dispersive X-ray analysis. 1982. J.A.G. van Rhyn

PEARS/PERE

• *Physiology/Fisiologie*

- VV.2442/03/2/1: The effect of viruses on the performance of pear cultivars. 1972. H.J. van Zyl

- VV.2442/03/2/2: Growth control of pears with growth retardants. 1982. H.J. van Zyl
- VV.2442/03/5/1: Effect of calcium, hormones and seed content on premature ripening of pears. 1982. H.J. van Zyl
- VV.2442/03/5/3: Effect of fluctuation in orchard temperature on premature ripening of pears. 1983. H.J. van Zyl
- VV.2442/03/5/4: Anatomical study of poor keeping quality of Bon Chretien pears. 1984. P. van der Merwe

- *Nutrition/Voeding*

- VV.2442/05/1/1: Pears: determination of the effect of soil pH and of potassium and nitrogen fertilisation on the growth, yield and fruit quality of pears. 1982. J. Wooldridge

- *Upgrading/Veredeling*

- VV.2442/07/1/1: Breeding of precocious late pear cultivars. 1977. J.H. Acker
- VV.2442/07/1/2: Breeding of pear cultivars resistant to scab. 1977. J.H. Acker
- VV.2442/07/1/4: Mutation breeding *in vitro* of Packham's Triumph pear to develop a compact growth habit. 1985. R.E. Pieterse

- *Pathology/Patologie*

- VV.2442/19/1/2: Factors affecting the development of calyx-end rot of pears. 1985. J.C. Combrink

- *Pests/Plae*

- VV.2442/20/1/1: Chemical control of codling moth on pears. 1977. T.L. Blomefield

- *Crop science/Gewaskunde*

- VV.2442/30/1/1: The planting and maintenance of pear cultivars. 1970. P.F. Louw
- VV.2442/30/1/2: Second phase evaluation of pear cultivars in the winter rainfall area. 1971. P.R. Jolly
- VV.2442/30/2/1: Evaluation of pear rootstocks in the winter rainfall area. 1971. P. van Huyssteen
- VV.2442/30/3/1: Increasing production of pears. 1978. P. van Huyssteen
- VV.2442/30/3/2: Comparison of training systems for pears in the Groot-Drakenstein area. 1983. P. van Huyssteen
- VV.2442/30/5/1: Rooting of BP2 pear rootstocks. 1978. P. van Huyssteen
- VV.2442/30/6/1: Effect of the characteristics of ridges on the performance of pear trees. 1986. J. Wooldridge

- *Technology/Tegnologie*

- VV.2442/52/1/1: Controlled-atmosphere storage of pears. 1982. A.B. Truter
- VV.2442/52/1/2: Effect of rate of re-cooling and atmosphere modification on pear quality. 1984. S. van Eeden

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- *Physiology/Fisiologie*

- VV.2443/03/2/1: Growth control of peaches with retardants. 1982. H.J. van Zyl

- VV.2443/03/4/3: Investigation of the physiological causes of woolliness of peaches. 1983. L.J. von Mollendorf
- VV.2443/03/4/4: Factors which cause pit burn and internal breakdown in peaches. 1984. W.A.G. Kotzé
- VV.2443/03/4/5: Determining reliable maturity indexes for clingstone peach cultivars for fresh marketing. 1986. T.R. Visagie
- VV.2443/03/4/6: Effect of ring barking at pip hardening on fruit development, fruit quality and carbohydrate composition of Culemborg and Armking peach trees. 1968. H. de Villiers

• *Nutrition/Voeding*

- VV.2443/05/1/2: Scheduling of nitrogen application through the irrigation system for peaches (nectarines). 1982. M. du Preez
- VV.2443/05/1/3: Practical manipulations to increase the urease activity of sandy soils in peach orchards. 1985. M. du Preez
- VV.2443/05/1/4: Rate and depth of nitrogen leaching in peach orchard soils with micro-irrigation. 1984. K.D. Fuller

• *Upgrading/Veredelings*

- VV.2443/07/1/5: Breeding improved peach and nectarine cultivars that are adapted to the various production areas of South Africa. 1984. J.H. Acker
- VV.2443/07/1/6: Embryo culture of peaches. 1986. A. Rabie
- VV.2443/07/1/7: Pollen culture of peaches. 1986. A. Rabie

• *Pests/Plae*

- VV.2443/20/2/1: Bionomics of false codling moth on peaches. 1982. M.A. Venter

• *Crop science/Gewaskunde*

- VV.2443/30/1/1: The planting and maintenance of peach cultivars. 1970. W.J.C. Smith
- VV.2443/30/1/2: Second phase evaluation of peach cultivars in the Western Cape. 1971. C.W.J. Bester
- VV.2443/30/1/3: Evaluation of dessert peach and nectarine cultivars and selections in the summer rainfall region. 1976. L.L. van der Merwe
- VV.2443/30/1/5: Evaluation of peach breeding lines in Natal. 1981. P.C. van Rooyen
- VV.2443/30/1/6: Morphology of peach pollen for cultivar identification. 1986. P. van der Merwe
- VV.2443/30/2/2: Peaches: evaluation of peach rootstocks at Robertson Experiment Farm. 1982. J.D. Stadler
- VV.2443/30/3/2: Optimum plant density and cultivation practices for peaches in high density plantings in the summer rainfall region. 1978. T.K. Haulik
- VV.2443/30/3/3: Comparison of plant and training systems for peaches. 1984. J.D. Stadler
- VV.2443/30/3/4: Comparison of plant and training systems for peaches in the summer rainfall area. 1985. R.A.W. Gardener
- VV.2443/30/4/1: Efficiency and phytotoxicity of herbicides when used together with peaches. 1984. A.F. Lourens

• *Water requirements/Waterbehoefes*

- VV.2443/31/1/1: Lysimeter studies on irrigation scheduling with peaches. 1979. H. Tormann
- VV.2443/31/1/2: Effect of irrigation scheduling and soil moisture regimes on the yield and quality of peaches (nectarines). 1985. O. Beukes

- *Chemical control/Chemiese beheer*

OP.3241/21/1/1: Chemical control of helminths with special reference to resistance. 1982. J.A. van Wyk

- *Technology/Tegnologie*

OP.3241/52/1/1: Helminths: long-term storage of pure strains of helminths. 1973. J.A. van Wyk

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Reproduction investigations/Reproduksie-ondersoeke

INFERTILITY/ONVRUGBAARHEID

- *Pathology/Patologie*

OP.3251/19/1/1: Diagnostics of infertility and abortion in animals. 1973. Lesley A. te Brugge

OP.3251/19/1/2: Serodiagnostics of infertility, abortion and other diseases. 1981. S. Herr

OP.3251/19/2/2: Infertility: immunity to trichomoniasis in cattle. 1981. S. Herr

OP.3251/19/2/3: Infertility: ulcerative dermatosis in sheep. 1981. C.J.V. Trichard

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Entomological investigations/Entomologiese ondersoeke

EXTERNAL PARASITES/EKSTERNE PARASIEDE

- *Entomology/Entomologie*

OP.3261/14/1/1: External parasites: identification and systematics of insects of veterinary importance. 1981. E.M. Nevill

- *Acarology/Akarologie*

OP.3261/15/1/1: External parasites: identification and systematics of ticks and mites of veterinary importance. 1981. J.B. Walker

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OP.3261/19/1/1: External parasites: *Cowdria ruminantium* in *Amblyomma hebraeum*. 1977. J.D. Bezuidenhout

OP.3261/19/1/2: External parasites: multiplication of arboviruses in *Culicoides* spp. 1973. E.M. Nevill

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• *Pests/Plae*

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VIRUSES/VIRUSSE

• *Pathology/Patologie*

- OP.3271/19/1/1: Diagnostics of virus diseases of animals. 1981. B.J. Erasmus
- OP.3271/19/2/3: Growth attenuation of African horse sickness viruses in tissue culture. 1968. B.J. Erasmus
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Highly contagious diseases/Hoogsaansteeklike siektes

HIGHLY CONTAGIOUS VIRUSES/HOOGSAANSTEEKLIKE VIRUSSE

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- OP.3281/19/1/1: Diagnostics of highly contagious virus diseases of animals. 1980. G.R. Thomson
- OP.3281/19/1/2: Highly contagious viruses: the development of ELISA techniques for the detection of foot-and-mouth disease (FMD) and swine vesicular disease (VSD) viruses and antibodies directed against them. 1985. J.J. Esterhuyzen

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POULTRY/PLUIMVEE

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- OP.3291/19/1/1: Diagnostics of disease conditions of poultry. 1981. F.W. Huchzermeyer
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FISH/VIS

• Pathology/ Patologie

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Bacterial investigations/Bakteriese ondersoeke

BACTERIA/BAKTERIEë

• Pathology/ Patologie

- OP.32101/19/1/1: Diagnostics of bacterial diseases of animals. 1981. Marijke M. Henton
- OP.32101/19/2/4: Bacteria: improvement of *E. coli* vaccines. 1982. P. Oberem
- OP.32101/19/2/6: Bacteria: development of an effective *Clostridium septicum* vaccine. 1983. M.J. de Bruyn
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PROTOZOA/PROTOSOA

• Pathology/ Patologie

- OP.32111/19/1/1: Diagnostics of protozoal and rickettsial diseases of animals. 1981. D.T. de Waal
- OP.32111/19/2/1: Protozoa: quality, safety and efficacy of Onderstepoort vaccines against bovine babesiosis. 1981. D.T. de Waal

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Molecular biological investigations/Molekulêre biologiese ondersoeke

MACROMOLECULES/MAKROMOLEKULE

• Virology/Virologie

- OP.32/21/12/1/3: Macromolecules: serological studies of jaagsiekte retrovirus. 1982. M.S. Myer
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Biochemical investigations/Biochemiese ondersoeke

BIOCHEMICAL INVESTIGATIONS/BIOCHEMIESE ONDERSOEKE

• Virology/Virologie

- OP.32/31/12/1/1: Biochemical investigations: *in vitro* activation of transcriptase activity with bluetongue virus. 1979. Alberdina A. van Dijk
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POISONS/GIFSTOWWE

• Toxicology/Toksikologie

- OP.32141/18/1/1: Poisons of and poisoning by cardiac glycosides from plants of the family Crassulaceae. 1981. L.A.P. Anderson
- OP.32141/18/1/2: Poisons of and poisoning caused by *Cynanchum* species. 1981. G.L. Erasmus
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AGRICULTURAL RESOURCE UTILISATION LANDBOUHULPBRONBENUTTING

RESOURCE RESEARCH/HULPBRONNAVORSING

Primary resources/Primêre hulpbronne

SOIL/GROND

• *Soil science/Grondkunde*

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- GB.5111/32/3/1: The distribution and properties of liming materials and waste products with reference to suitability for amelioration of RSA soils. 1979. H.C.H. Hahne
- GB.5111/32/3/2: Silicon-phosphorus-sesquioxide relationships with a view to amelioration of acid soils with silicate. 1979. H.C.H. Hahne
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- GB.5111/32/3/7: The dynamics of neutralising agents of porous inert media and soil in a larger area. 1985. A.J. van der Merwe
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- GB.5111/32/8/2: The significance of N losses by means of denitrification in the RSA soils. 1985. A.D.P. Botha
- GB.5111/32/8/3: A study of some South African soils in which K fixation is a problem. 1985. W.F.A. Kirsten
- GB.5111/32/8/4: Hydrolysis of urea in the summer rain cropping soils. 1985. L. Korentajer

- GB.5111/32/8/5: Extractable soil nitrogen: evaluation of factors affecting the reliability of the equilibrium method using Auto Analyser methods for the determination of nitrogen. 1986. J.C. Johnson
- H.5111/32/1/1: The influence of liming on the acidic properties of dominant soils in the Highveld Region with maize as an indicator plant. 1979. D.J. Beukes
- H.5111/32/1/2: Micro-element status of Hutton, Clovelly and Avalon soils in the Highveld Region at different degrees of soil acidity. 1981. D.J. Beukes
- H.5111/32/3/2: The soil moisture holding capacity of soils in the Highveld Region. 1981. A.M. Hattingh
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- H.5111/32/5/1: The effects of different levels of phosphorus and nitrogen on crop yield on a Rensburg soil series under stubble mulch tillage in the Highveld Region. 1984. D.J. Beukes
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- N.5111/32/1/1: Evaluation of scooped soil density as a rapid measure of phosphorus fixation and soil texture. 1985. M.A. Johnston
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- T.5111/32/1/3: Soil: effect of rock phosphate and double super phosphate on optimal maize production. 1980. G.J. du Toit
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- V.5111/32/1/5: Soil: a comparison of different nitrogen sources for wheat on a Hutton soil at Vaalharts. 1983. P.J. Snyman
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- V.5111/32/1/9: Soil: the effect of fertiliser on the sulphur status of a Dundee soil at Upington. 1985. A. van Schalkwyk
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- W.5111/32/2/1: Soil: a study of the correlations between chemically extractable phosphorus and phosphorus absorption by different crops in the Winter Rainfall Region. 1974. G.R. Thompson

- W.5111/32/2/2: Soil: the effect of potassium fertilising levels on the growth and yield of wheat in the winter rain cropping area. 1977. C.P. de L. Beyers
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• *Water requirements/ Waterbehoefes*

- GB.5112/31/1/4: Flood irrigation design criteria establishment for major South African soils. 1981. D.A. Russell
- GB.5112/31/2/1: Determination of water requirements of certain annual crops at Roodeplaat as a function of soil, plant and atmospheric factors. 1976. A.J. van der Merwe

• *Soil science/ Grondkunde*

- GB.5112/32/1/1: Reclamation of salt and sodic soils: influence of exchangeable sodium, exchange equilibria and electrolyte concentration of irrigation water. 1972. H.J.C. Smith

CLIMATE/KLIMAAT

• *Water requirements / Waterbehoefes*

- GB.5113/31/1/1: The value of climatic formulae (temperature) to estimate potential evapotranspiration in the summer rainfall area. 1981. B. St. E. Clemence

• *Meteorology/ Weerkunde*

- GB.5113/33/1/1: Acquisition and processing of climatic data of the RSA. 1978. A.V. Kotze
- GB.5113/33/1/2: Climate: drought investigation in order to provide an index for drought determination from meteorological data. 1979. J. Pollock
- GB.5113/33/1/3: Agroclimate of subtropical crops. 1978. N.B. Human
- GB.5113/33/1/4: Climate: the determination and classification of the moisture supply potential of natural rainfall. 1978. J.F. Eloff
- GB.5113/33/1/8: Climate: wind surveys in citrus production areas. 1978. N.B. Human
- GB.5113/33/1/9: Climate: total radiation in the Winter Rainfall Region. 1980. G.W. Matthee
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- GB.5113/33/3/1: Microclimatic study of the Theewaterskloof Dam terrain. 1978. G.K. Viljoen
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- GB.5113/33/4/1: In-time identification and prediction of unfavourable weather conditions for the Angora goat industry (climate). 1980. D.I. Rowsell

Energy/Energie

FUELS/BRANDSTOWWE

• *Engineering/Ingenieurskunde*

- LI.5121/51/1/1: Research on and development of plant oils and alcohols for engines in agriculture. 1979. J. Fuls

Surveys and demarcation/Opnames en afbakening

SOIL SURVEYS/GRONDOPNAMES

• *Soil science/Grondkunde*

- D.5131/32/1/1: Soil surveys in the Dohne-Bolo area. 1979. M.D. Hartmann
- D.5131/32/1/2: Soil surveys for run-off control planning on pineapple farms of the Western Study Group in the Bathurst/Alexandria area. 1986. L.R. Hall
- GB.5131/32/1/1: Land type survey (terrain form, soils, climate) of the Highveld Region. 1979. J.L. Schoeman
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- GB.5131/32/1/7: Land type survey (terrain form, soils, climate) of the Karoo Region. 1973. F. Ellis
- GB.5131/32/2/1: Standard 1:50 000 soil survey of the Pretoria-Witwatersrand-Vereeniging complex. 1973. T.U. Yager
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VELD SURVEYS/VELDOPNAMES

• *Situation analysis/Situasiebepaling*

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- K.5132/38/1/2: Veld surveys: determination of the erosion condition of the veld and lands in North-east subregion of the Karoo Region. 1986. P.V. de Bruyn
- K.5132/38/1/3: Veld surveys: determination of the erosion condition of the veld and lands in the North-west Karoo subregion of the Karoo Region. 1986. G.J.J. Steenkamp
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WATER SURVEYS/WATEROPNAMES

• *Situation analysis/Situasiebepaling*

- D.5133/35/1/1: Water surveys in the Dohne-Bolo area. 1980. R.F.M. Childs

FAIRLY HOMOGENEOUS AGRICULTURAL AREAS/REDELIK HOMOGENE BOERDERYGEBIEDE

• *Ecology/Ekologie*

- K.5134/27/1/1: RHFA: a plant ecological study of the Karoo Region in terms of land types. 1983. M. Vorster
- K.5134/27/2/1: RHFA: classification of irrigation areas in the Extension Ward Cradock. 1980. P.S. van Heerden

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- K.5134/27/3/9: Demarcation of fairly homogeneous agricultural areas in the Calvinia Extension Ward. 1983. A.J. Siepker
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- K.5134/27/3/12: Demarcation of fairly homogeneous agricultural areas in the Prieska Extension Ward. 1983. A.J. Siepker
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- H.5134/36/1/3: The provision of production norms and techniques for agricultural commodities for various resource situations within RHFA's of the Highveld Region. 1981. J.J. Scheepers
- H.5134/36/1/4: The description of production possibilities of natural resources per magisterial district according to RHFA subdivisions in the Highveld Region. 1983. B.P. Ludick
- H.5134/36/1/5: The classification of natural resources into ecotopes within 57 RHFA's in the Highveld Region. 1984. B.P. Ludick

• *Situation analysis/Situasiebepaling*

- N.5135/35/1/1: Present land use survey of Natal (Agriquest). 1979. J.B.M. Smith
T.5135/35/1/1: Analysis of situation land use - Silverton. 1978. J.B. Stevens

OTHER SURVEYS/ANDER OPNAMES

• *Situation analysis/Situasiebepaling*

- D.5136/35/1/1: A situation survey of present farming practices in the Stutterheim Extension Ward. 1983. P.G. King
HK.5136/35/1/1: An investigation into woolled sheep farming in the Republic of South Africa. 1982. R.E.D. Bradfield
HK.5136/35/2/1: Other surveys: an investigation into factors inhibiting the adoption of recommended veld management practices in the recognised grazing areas of the RSA. 1984. C.H. de Klerk
HK.5136/35/3/1: Other surveys: an investigation into the adoption of recommended agricultural practices in the summer rain cropping areas owing to the provision of co-ordinated information to farmers. 1985. C.H. de Klerk
N.5136/35/1/1: Changes in the extent of agriculturally eroded areas in Natal since 1950 and the relationship of such changes with land use modification and an evaluation of erosion status and sediment delivery in Natal. 1983. W.B. Russell

• *Potential studies/Potensiaalstudies*

- HK.5136/36/1/1: Other surveys: agricultural development plan for Rehoboth Gebiet. 1982. C.H. de Klerk

• *Extension science/Voorligtingkunde*

- HK.5136/40/1/1: Other surveys: an investigation into the efficiency of study groups in Transvaal. 1984. C.H. de Waal

Irrigation development/Besproeiingsontwikkeling

IRRIGATION PLANNING/BESPROEIINGSBEPLANNING

• *Evaluation/Evaluasie*

- GB.5141/37/1/1: Evaluation of areas for irrigation development and farm layout on State Schemes. 1979. J. Myburgh
GB.5141/37/1/2: Evaluation of existing irrigation schemes. 1982. J. Myburgh

**RESOURCE UTILISATION RESEARCH (CROPS)
HULPBRONBENUTTINGSNAVORSING (GEWASSE)**

Field crops/Landgewasse

SUMMER GRAIN/SOMERGRAAN

• *Physiology/Fisiologie*

- N.5211/03/1/1: Aluminium tolerance of maize cultivars in Natal. 1982. R.J. Bennet

- *Nutrition/Voeding*

- D.5211/05/1/1: Summer grain: NPK nutrition of maize at Dohne. 1978. R.S. Marr
- D.5211/05/1/2: Summer grain: NPK nutrition of maize at Sternberg. 1978. R.S. Marr
- D.5211/05/1/3: Summer grain: NP nutrition of maize at Sternberg. 1980. R.S. Marr
- D.5211/05/1/4: Summer grain: NP nutrition of maize at Ugie. 1980. R.S. Marr

- *Pests/Plae*

- T.5211/20/1/1: Summer grain: survey of fungus-growing termites on agronomic crops. 1977. H.H. Gouse

- *Crop science/Gewaskunde*

- D.5211/30/1/1: Summer grain: maize planting dates at Dairyland, Bathurst. 1979. R.S. Marr
- D.5211/30/1/2: Summer grain: maize planting dates at Redlands, Bathurst. 1979. R.S. Marr
- D.5211/30/1/3: Summer grain: maize planting dates at Dohne. 1978. R.S. Marr
- H.5211/30/1/1: Summer grain: verification of production techniques and yield norms for grain sorghum on an Arcadia soil form in the Highveld Region. 1985. G.H. Koen
- H.5211/30/1/2: Summer grain: verification of production techniques and yield norms for maize on a Bainsvlei soil form in the Highveld Region. 1985. H.S. Lombard
- V.5211/30/1/1: Summer grain: irrigation and nitrogen fertilisation studies with maize at Upington. 1985. A. van Schalkwyk
- V.5211/30/1/2: Summer grain: irrigation and nitrogen fertilisation studies with maize at Vaalharts. 1985. A. van Schalkwyk
- V.5211/30/2/1: Summer grain: crop residue management and seedbed preparation practices for dryland maize in a monoculture system at Sandvet. 1986. C. Engelbrecht

- *Potential studies/Potensiaalstudies*

- D.5211/36/2/1: Summer grain: production and economic norms of no-till maize on a commercial scale at Dohne. 1983. J.A.G. Nel

- *Modelling/Modellering*

- H.5211/42/1/1: The development of a simulation type model to predict production of the more important summer grains in the Highveld Region. 1985. P.J. van Rooyen

SMALL GRAIN/KLEINGRAAN

- *Physiology/Fisiologie*

- W.5212/03/1/1: Small grain: the biology of ridgetop brome (*Bromus diandrus*) in the Winter Rainfall Region. 1985. F.H. Eksteen

- *Nutrition/Voeding*

- W.5212/05/1/1: Small grain: the influence of time and amount of application of nitrogen fertiliser on wheat production in the Winter Rainfall Region. 1980. J.W. Loubser

- *Pathology/Patologie*

- V.5212/19/1/1: Small grain: the effect of cultivars, soil/water regime and *Fusarium inoculum* levels at planting time on dryland wheat production at Glen. 1985. O. Los

- V.5212/19/1/2: Small grain: geographic distribution of *Fusarium* spp. associated with crown rot in dryland wheat in the Free State Region. 1985. O. Los
- V.5212/19/2/1: Small grain: investigations on the occurrence of root disease organisms of wheat in an experimental plot under irrigation at Vaalharts. 1985. J.P. Rheeder
- *Pests/Plae*
- V.5212/20/1/1: Small grain: investigation on the occurrence of the brown wheat mite under dryland conditions at Glen. 1984. J. de Jager
- V.5212/20/1/2: Small grain: investigations on the effect of the brown wheat mite on grain yield, as well as possible control measures under dryland conditions at Glen. 1984. J. de Jager
- W.5212/20/1/1: Small grain: a study of the identity, occurrence, biology and ecology of aphids on small grain in the Winter Rainfall Region. 1975. S.S. Walters
- W.5212/20/1/2: The pest status of aphids associated with small grain in the Winter Rainfall Region. 1978. S.S. Walters
- W.5212/20/1/3: Small grain: bio-ecological study of *Sitobion avenae* on small grain in the winter rain cropping area of the Winter Rainfall Region. 1984. J.M. Laubscher
- W.5212/20/3/1: Small grain: factors influencing the distribution and abundance of the dune snail, *Theba pisana* and related pest snails in the Winter Rainfall Region. 1986. W.F. Sirgel
- *Chemical control/Chemiese beheer*
- W.5212/21/1/1: Chemical weed control of different broad leaf and grass weeds in small grain production in the Winter Rainfall Region. 1974. J.W. Loubser
- W.5212/21/1/2: The influence of chemical pre-emergence control of weeds on the yield of cereals in the Winter Rainfall Region. 1977. J.W. Loubser
- *Crop science/Gewaskunde*
- H.5212/30/1/1: Small grain: verification of production techniques and yield norms for wheat on an Avalon soil form in the Highveld Region. 1985. G.G.J. Oosthuizen
- V.5212/30/1/1: Small grain: irrigation and nitrogen fertilisation studies with wheat in the Lower Orange River area at Upington. 1983. A. van Schalkwyk
- V.5212/30/1/2: Small grain: irrigation and nitrogen fertilisation studies with wheat in the Vaalharts irrigation area. 1983. A. van Schalkwyk
- V.5212/30/1/3: Small grain: irrigation and nitrogen fertilisation studies with wheat grown in rotation with maize at Vaalharts. 1984. A. van Schalkwyk
- V.5212/30/2/1: Small grain: evaluation of crop residue management, soil tillage and wheat control practices within specific systems of dryland wheat production at Glen. 1982. A.J. van der Westhuizen
- V.5212/30/2/2: Small grain: evaluation of minimum tillage and stubble mulch practices in dryland wheat production at Glen. 1984. A.J. van der Westhuizen
- V.5212/30/2/3: Small grain: the effect of different soil management practices during long fallow preceeding dryland wheat on physical soil condition and occurrence of wind erosion at Bainsvlei. 1984. A.J. van der Westhuizen
- V.5212/30/2/4: Small grain: evaluation of minimum tillage and stubble mulch practices in dryland wheat production at Sandvet. 1984. A.J. van der Westhuizen
- W.5212/30/1/1: Small grain: the evaluation of released cultivars in respect of yield and quality in the Winter Rainfall Region. 1974. G.A. Agenbag
- W.5212/30/2/1: Small grain: the influence of sowing date, seeding rate, variety, nitrogen application and disease control on yield and quality of barley in the Winter Rainfall Region. 1974. F.P. Goosen

- W.5212/30/2/2: Small grain: the influence of disease control, nitrogen fertilisation and seeding rate on the yield and nitrogen content of malting barley in the Winter Rainfall Region. 1985. F.P. Goosen
- W.5212/30/2/3: Small grain: the influence of disease control, nitrogen fertilisation and seeding rate on the yield and nitrogen content of malting barley under supplementary irrigation in the Winter Rainfall Region. 1985. F.P. Goosen
- W.5212/30/3/1: Small grain: the influence of sowing time, rate of seeding variety and nitrogen application on yield and quality of wheat in the Winter Rainfall Region. 1985. G.A. Agenbag
- W.5212/30/3/2: Small grain: influence of genotype, environment and nitrogen fertiliser on quality components of wheat in the Winter Rainfall Region. 1985. W.R.M. de Witt
- W.5212/30/4/1: Small grain: the effect of cultivation methods in different cropping systems on grain yield and soil improvement in the Swartland production area of the Winter Rainfall Region. 1975. G.A. Agenbag
- W.5212/30/4/2: Small grain: the effect of cultivation methods in different cropping systems on grain yield and soil improvement in the Ruens production area of the Winter Rainfall Region. 1976. G.A. Agenbag
- W.5212/30/4/3: Small grain: the effect of cultivation methods in different cropping systems on grain yield and soil improvement in the George-Knysna production area of the Winter Rainfall Region. 1979. G.A. Agenbag
- W.5212/30/5/1: A study of the adaptability of small grain species and cultivars in the Winter Rainfall Region for fodder grain purposes. 1985. F.H. Eksteen

OIL AND PROTEIN SEEDS/OLIE- EN PROTEÏENSADE

• *Physiology/Fisiologie*

- W.5213/03/1/1: Oil and protein seeds: effect of time of application of a seaweed growth regulator on growth, development and seed yield of lupins. 1986. H.J.C. Agenbag

• *Nutrition/Voeding*

- H.5213/05/1/1: Oil and protein seeds: the growth and yield of soybeans on a Bainsvlei soil form in the Highveld Region as influenced by different phosphate levels. 1983. P.J. Laubscher

• *Upgrading/Veredeling*

- W.5213/07/1/1: Oil and protein seeds: upgrading of lupins for the winter rain cropping areas by means of genetic studies and breeding. 1981. H.J.C. Agenbag

• *Chemical control/Chemiese beheer*

- W.5213/21/1/1: Oil and protein seeds: chemical control of powdery mildew (*Erysiphe polygoni*) on different cultivars of *Lupinus angustifolius*. 1986. H.J.C. Agenbag
- W.5213/21/2/1: Oil and protein seeds: chemical weed control in *L. albus* and *L. angustifolius* in the winter rain cropping area. 1986. J.W. Loubser

• *Crop science/Gewaskunde*

- W.5213/30/1/1: Oil and protein seeds: a study of the adaptability and methods of cultivation of joboba (*Simmondsia chenensis*) in the Winter Rainfall Region. 1980. D.J. le Roux
- W.5213/30/1/2: Oil and protein seeds: the evaluation of cultivars of different species of lupins with respect to adaptability disease resistance and yield in the Winter Rainfall Region. 1958. H.J.C. Agenbag

- W.5213/30/2/1: Oil and protein seeds: lupin cultivar evaluation in the Winter Rainfall Region. 1986. H.J.C. Agenbag
- W.5213/30/3/1: Oil and protein seeds: determination of optimum time of planting and plant density of different lupin varieties in the Winter Rainfall Region. 1986. H.J.C. Agenbag
- W.5213/30/3/2: Oil and protein seeds: effect of row spacing on plant development and seed yield of *Lupinus albus*. 1986. H.J.C. Agenbag

OTHER FIELD CROPS/ANDER LANDGEWASSE

• Nutrition/Voeding

- D.5214/05/1/1: Other field crops: NPK nutrition of chicory at Bathurst. 1980. R.S. Marr
- W.5214/05/1/1: Other field crops: the influence of nitrogen topdressings on peppermint (*Mentha piperita*) grown in the Winter Rainfall Region. 1985. H.H.M. van Gelder

• Upgrading/Veredeling

- D.5214/07/1/1: Other field crops: upgrading of existing chicory cultivars in the Eastern Cape. 1974. R.S. Marr

• Crop science/Gewaskunde

- D.5214/30/1/1: Other field crops: the contribution of chicory cultivars in the Eastern Cape. 1973. R.S. Marr
- D.5214/30/1/4: Other field crops: crop rotation for chicory in the Eastern Cape. 1980. R.S. Marr
- D.5214/30/1/5: Other field crops: chicory cultivar evaluation in the Eastern Cape. 1974. R.S. Marr
- W.5214/30/1/1: The evaluation of techniques and methods for application of nutrients and irrigation to other crops in a research glasshouse. 1984. H.H.M. van Gelder
- W.5214/30/2/1: Other field crops: the evaluation of peppermint (*Mentha piperita*) for adaptation in the Winter Rainfall Region. 1985. H.H.M. van Gelder

Garden crops/Tuingewasse

TUBER CROPS/KNOLGEWASSE

• Pests/Plae

- W.5221/20/1/1: Tuber crops: the migratory habits of aphid vectors of potato viruses in the seed potato producing areas of the winter rain cropping area. 1976. S.S. Walters

VEGETABLES/GROENTE

• Pathology/Patologie

- N.5222/19/2/1: Vegetables: effect of different fungicides on the development of late blight, early blight and *Septoria* leaf spot in the vegetable cultivars "Floradade" and "Roma". 1984. W.G. Nevill
- N.5222/19/2/2: Vegetables: effect of different fungicides on the development of late blight, early blight and *Septoria* leaf spot on the tomato cultivar Moneymaker. 1985. W.G. Nevill

- N.5222/19/2/3: Vegetables: effect of different fungicide spray application schedules on the progress of early blight on tomato cultivars. 1985. W.G. Nevill
- N.5222/19/2/4: Effect of nitrogen, phosphorus and potassium fertilisation on the development of early blight on tomato cultivars. 1985. W.G. Nevill

• *Crop science/Gewaskunde*

- N.5222/30/1/1: Vegetables: cultivar evaluation of vegetables in the mist belt of the high rainfall areas of Natal and the effects of selected fungicides on foliar disease development. 1985. G.W. Staveley

OTHER GARDEN CROPS/ANDER TUINGEWASSE

• *Crop science/Gewaskunde*

- W.5223/30/1/1: Other garden crops: status determination with regard to the commercial utilisation of the Proteaceae in the Winter Rainfall Region. 1985. C.J. Eksteen

Fruit crops/Vrugtegewasse

GRAPES/DRUIWE

• *Pests/Plae*

- W.5232/20/1/1: Distribution and movement patterns of the Cape sparrow *Passer melanurus* (Müller) - a problem bird of grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis
- W.5232/20/1/2: Food composition and feeding habits of the Cape sparrow *Passer melanurus* (Müller) - a problem bird of grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis
- W.5232/20/1/3: Control techniques for the Cape sparrow *Passer melanurus* (Müller) in grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis

**RESOURCE UTILISATION RESEARCH (ANIMALS)
HULPBRONBENUTTINGSNAVORSING (DIERE)**

Ruminants/Herkouers

LARGE STOCK/GROOTVEE

• *Physiology/Fisiologie*

- D.5311/03/1/1: Large stock: hormonal status and calving percentage of beef cows and heifers in the sourveld. 1979. J.A. Erasmus
- D.5311/03/1/2: Large stock: protein energy status and calving percentage of beef cows and heifers in the sourveld. 1980. J.A. Erasmus
- D.5311/03/2/1: Large stock: the influence of kikuyu on the sexual maturity of Friesian heifers. 1984. J.A. Erasmus
- D.5311/03/2/2: Large stock: influence of kikuyu on the protein and energy status as well as certain endocrinological secretions in cows. 1984. J.A. Erasmus
- D.5311/03/2/3: Large stock: influence of kikuyu pastures on the protein and energy status of dairy heifers. 1984. W.P. Henning

- T.5311/03/1/2: Large stock: influence of different over-wintering feeding regimes on production and growth of beef cattle. 1971. P. Langenegger
- T.5311/03/1/3: Large stock: milk and meat production from a dual purpose breed on natural veld and dryland *Cenchrus* pastures. 1984. E.E. Lademann

• *Reproduction/ Reproduksie*

- N.5311/04/1/1: Effect of preparation feeding levels and target mass at mating on reproduction in female beef cattle. 1979. A.P. van Schalkwyk
- N.5311/04/1/2: Oestrus and ovulation in mature female beef cattle as affected by changes in live mass. 1978. B.P. Louw
- N.5311/04/1/4: Large stock: reproduction in the beef female as influenced by bull libido in the high rainfall sourveld area at Dundee. 1983. J.S. Crichton
- N.5311/04/1/5: Large stock: the relationship between libido and mating activity in Zebu bulls. 1987. J.S. Crichton
- V.5311/04/1/1: Large stock: an investigation on practical methods for shortening the inter-calving period of Afrikaner cattle at Armoedsvlakte. 1979. J.A. Vermeulen
- V.5311/04/1/2: Large stock: control of LH release during synchronised oestrus of beef cows at Armoedsvlakte. 1979. J.A. Vermeulen
- V.5311/04/1/3: Large stock: an investigation on the use of gonadotrophin releasing hormone in the application of AI with beef cows at Armoedsvlakte. 1979. J.A. Vermeulen

• *Nutrition/ Voeding*

- D.5311/05/1/1: Large stock: the relationship in the seasonal variation in beta carotene of sourveld and beta carotene of blood plasma in beef cows. 1983. P.J.L. Zeeman
- D.5311/05/1/2: Large stock: the influence of beta carotene supplementation on the reproduction of beef cows. 1983. J.A. Erasmus
- D.5311/05/1/3: Large stock: the influence of reproduction on diet selection of beef cattle grazing high rainfall sourveld. 1983. P.J.L. Zeeman
- D.5311/05/1/4: Large stock: the influence of reproduction on diet selection of beef cattle grazing sweet grassveld. 1983. P.J.L. Zeeman
- D.5311/05/2/1: Large stock: the evaluation of kikuyu pastures for milk production. 1984. W.P. Henning
- D.5311/05/2/2: Large stock: the evaluation of kikuyu pastures for dairy heifers. 1984. P.J. Olivier
- D.5311/05/2/3: Large stock: the influence of alkali treatment of whole maize on milk production. 1984. W.P. Henning
- H.5311/05/1/3: Large stock: the optimal level of phosphorus supplementation for beef cows on summer veld in the Highveld Region. 1985. A.R. Schutte
- H.5311/05/2/1: Large stock: preservation and protein stabilisation of maize silage. 1978. L.D. Snyman
- H.5311/05/2/2: Large stock: the utilisation of ensiled mixtures of cattle manure and maize crop residues by large stock. 1983. L.D. Snyman
- H.5311/05/2/4: Large stock: the fattening of weaner beef steers on maize-, grain sorghum- and forage sorghum-silage. 1986. A.R. Schutte
- H.5311/05/3/1: Large stock: the influence of different soybean flour-, whey powder- and colostrum-based milk replacers on post-weaning growth of dairy calves. 1982. C.W. Cruywagen
- H.5311/05/3/2: Large stock: concentrate supplement for dairy bull calves which received different ratios of soymeal, whey powder and colostrum. 1982. J.W. Cilliers
- H.5311/05/3/3: Large stock: the inclusion of different buffer levels in starter concentrates for dairy calves. 1985. C.W. Cruywagen

- H.5311/05/3/4: Large stock: the effect of curd forming ability of colostrum on the absorption of antibodies in dairy calves. 1985. C.W. Cruywagen
- H.5311/05/3/5: Large stock: different concentrate to roughage ratios in complete rations for Friesland bull calves. 1985. C.W. Cruywagen
- H.5311/05/3/7: Large stock: the effect of level of milk feeding and weaning age on pre- and post-weaning growth of Friesian bull calves. 1986. Joretha G. Horn
- H.5311/05/4/1: Large stock: milk production from winter cereal pastures on a shallow Avalon soil in the eastern Free State. 1979. J.W. Cilliers
- H.5311/05/4/3: Large stock: milk production with maize silage or pasture as sources of roughage for dairy cows. 1984. Joretha G. Horn
- H.5311/05/5/1: Large stock: the utilisation of cultivated summer pasture by Friesland heifers from weaning up to six months of age. 1985. Joretha G. Horn
- H.5311/05/5/2: Large stock: the utilisation of cultivated winter pasture by Friesland heifers from weaning up to six months of age. 1985. Joretha G. Horn
- H.5311/05/5/3: Large stock: the dry matter intake and mass gain of Friesland heifers (spring calves) from six to 24 months of age on cultivated pasture. 1985. Joretha G. Horn
- H.5311/05/5/4: Large stock: dry matter intake and mass gain of Friesland heifers (autumn calves) from six to 24 months of age on cultivated pasture. 1986. Joretha G. Horn
- H.5311/05/6/1: Large stock: *in vitro* evaluation of the grain of different sorghum varieties for possible inclusion in concentrates of dairy cows. 1985. C.W. Cruywagen
- N.5311/05/1/1: Large stock: the chemical composition and nutritive value of veld for beef cattle in bioregions 3 and 4. 1971. A.D. Lyle
- N.5311/05/2/1: Large stock: evaluation of *E. curvula* silage ensilaged at the May cutting stage for overwintering replacement of beef cattle heifers. 1981. A. van Niekerk
- N.5311/05/2/3: Large stock: utilisation of maize residues by pregnant beef cows in the high rainfall sourveld area at Dundee. 1985. J.S. Chrichton
- N.5311/05/3/1: Large stock: chemical composition and nutritive value of kikuyu pasture for lactating dairy cattle in the high rainfall sourveld areas. 1972. T.J. Dugmore
- N.5311/05/3/2: Large stock: chemical composition and nutritive value of Tall Fescue pasture for lactating dairy cattle in the high rainfall area at Cedara. 1980. T.J. Dugmore
- N.5311/05/3/3: Large stock: the causes of nutritional disorders of dairy cattle grazing kikuyu pastures damaged by army worms in the high rainfall sourveld area at Cedara. 1985. S.F. Lesch
- T.5311/05/1/1: Large stock: supplementary feeding of beef cattle cows with calves in the sweet bushveld. 1965. C.J.F. Lüdemann
- T.5311/05/1/2: Large stock: supplementary feeding on sweet bushveld and finishing in pens of growing beef cattle. 1965. C.J.F. Lüdemann
- T.5311/05/1/3: Large stock: supplementary feeding of growing cattle in the high rainfall sourveld. 1971. P. Langenegger
- T.5311/05/2/1: Large stock: the value of bush species for the survival of beef cattle in the bushveld. 1983. E.E. Lademann
- V.5311/05/1/1: Large stock: the evaluation of the nutritive value of veld with the aim at meat production at Vaalharts. 1974. E.A.N. Engels
- V.5311/05/1/2: Large stock: a study on the influence of phosphorus status on the production and reproduction of beef cattle on veld of Armoedsvlakte. 1978. E.A.N. Engels
- V.5311/05/1/3: Large stock: different levels of phosphorus supplementation of beef cows at Armoedsvlakte. 1984. M.V.P. Read
- V.5311/05/1/4: Large stock: dry matter intake of beef cattle on veld at Glen. 1969. E.A.N. Engels
- V.5311/05/2/1: Large stock: the application of cultivated roughages for milk production at Glen. 1978. S.W. Matthee

- V.5311/05/2/2: Large stock: the influence of frequency of concentrate feeding on the utilisation of roughage by dairy cows at Glen. 1983. S.W. Matthee
- V.5311/05/2/3: Large stock: the evaluation of annual rye grass for milk production at Glen. 1985. S.W. Matthee
- W.5311/05/1/1: Cultivated kikuyu pastures as a source of food for dairy cows in the Winter Rainfall Region. 1980. P.J. Swart
- W.5311/05/2/1: The substitution of lucerne hay with ammoniated wheat straw as the roughage component in the rations of lactating dairy cows in the Winter Rainfall Region. 1984. E.D. D'Hangest D'yvoy
- W.5311/05/3/1: The economic implications of concentrate and hay supplementation of dairy cows on artificial pastures. 1984. C.J.C. Muller

• *Upgrading/Veredeling*

- D.5311/07/1/1: Large stock: upgrading of the Edelheer and Roodebos Bonsmara breed strains in the high rainfall sourveld area. 1980. A.J. Fourie
- D.5311/07/1/2: Large stock: performance testing of bulls from the Edelheer and Roodebos Bonsmara strains in the high rainfall sourveld area. 1980. J.P. Compaan
- H.5311/07/1/1: Large stock: the influence of genetic and environmental factors on production traits of an Afrikaner cattle herd. 1983. J.J. Viljoen
- H.5311/07/1/2: Large stock: the influence of genetic and environmental factors on production traits of a Simmentaler cattle herd. 1986. J.J. Viljoen
- T.5311/07/1/1: Large stock: the comparison of pure and crossbred beef cattle in different breeding systems for the sweet bushveld. 1965. C.J.F. Lüdemann
- T.5311/07/1/2: Large stock: development and improvement of the Edelheer, Roodebos and Wesselsvlei breeding lines of the Bonsmara beef cattle race in the sour mixed bushveld at Rooideplaat. 1971. G. Marincowitz
- V.5311/07/1/1: Large stock: the use of different beef breeds as sires and dams in pure- and crossbreeding systems at Vaalharts. 1974. D.L. Els
- V.5311/07/1/2: Large stock: crossbreeding with the Afrikaner dam as basis with different large frame breeds under semi-intensive conditions at Vaalharts. 1973. D.L. Els
- V.5311/07/1/3: Large stock: the production potential of female crosses from Afrikaner cows with different large frame beef breeds at Vaalharts. 1976. D.L. Els
- V.5311/07/1/4: Large stock: the evaluation of the Belmont Red and Bonsmara beef breeds under extensive conditions at Vaalharts. 1982. D.L. Els
- V.5311/07/1/5: Large stock: the development and upgrading of the Wesselsvlei strain at Armoedsvlakte. 1980. D.L. Els
- V.5311/07/1/6: Large stock: the upgrading of Belmont Red halve crosses to an additional Bonsmara breeding line. 1986. H.S. Pottas

• *Management/Bestuur*

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• *Potential studies/ Potensiaalstudies*

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Non-ruminants/Nie-herkouers

OSTRICHES/VOLSTRUISE

• *Reproduction/Reproduksie*

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• *Nutrition/Voeding*

- W.5321/05/1/1: Finishing of slaughter ostriches for optimal leather production above 75 kg live mass. 1984. D. Swart
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• *Upgrading/Veredeling*

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• *Management/Bestuur*

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PIGS/VARKE

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**RESOURCE UTILISATION RESEARCH (PASTURES)
HULPBRONBENUTTINGSNAVORSING (WEIDING)**

Pasture/Weiding

VELD

• *Taxonomy/Taksonomie*

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• *Pests/Plae*

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T.5411/20/1/1: Veld: the incidence and influence of harvester termites on natural grazing pastures in the bushveld. 1983. H.H. Gouse

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• *Chemical control/Chemiese beheer*

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- N.5411/42/1/1: Determination of the relationship between veld condition, slope, soil erodibility and grazing capacity. 1980. P.C.V. du Toit
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- D.5413/05/1/1: Cultivated pasture: the yield of Rhodes grass at various nitrogen and phosphate levels at Bathurst. 1981. C.J.G. le Roux
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- D.5413/05/1/3: Cultivated pasture: the yield of *Eragrostis curvula* at various nitrogen and potassium levels at Dohne. 1985. L.G. Howe
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- N.5413/05/1/4: Phosphorus and potash requirements of *Eragrostis curvula* pastures on Leksand soils. 1974. P.E. Bartholomew
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- N.5413/05/1/7: Nutritional requirements of established kikuyu pastures: response to top-dressing. 1981. N. Miles
- N.5413/05/1/8: Response of kikuyu pastures to N, P and lime fertilisation on highly leached soils. 1982. N. Miles
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• Physiology/Fisiologie

- W.5416/03/1/1: Drought fodder crops: influence of season, genotype and soil type on the palatability and chemical composition of *Atriplex nummularia* in the Winter Rainfall Region. 1987. J. Aalbers

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- T.5417/05/1/1: Legume fodder crops: preliminary assessment of the responses of selected perennial pasture legumes to application of lime and superphosphate. 1983. D.L. Barnes

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- T.5417/30/1/2: Legume fodder crops: determination of daylength and temperature requirements for normal flowering in specific pasture and fodder legumes. 1977. A.J. Kruger
- T.5417/30/1/3: Legume fodder crops: screening of pasture legumes for soil acidity tolerance. 1977. A.J. Kruger
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Farming enterprises/Boerderyvertakkings

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- D.5511/36/1/3: Stock and game farming: development of a viable stock farming system for the dry grass-bush communities of the Eastern Cape Region. 1976. A.J. Aucamp
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- D.5511/36/1/5: Stock and game farming: development of a game production system for the Valley Bushveld in the Eastern Cape Region. 1985. J.E. Danckwerts
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LANDBOUPRODUKSIE-EKONOMIENAVORSING

Macro resource economy /Makrohulpbronekonomie

PRODUCTION FACTOR STUDIES/PRODUKSIEFAKTORSTUDIES

- *Production economics/ Produksie-ekonomie*

PE.5611/48/1/1: Production factor studies: the determination of a remuneration for the management function in agricultural concerns. 1980. J.S.G. Joubert

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- *Production economics/ Produksie-ekonomie*

PE.5612/48/1/1: Structural studies: the development of an alternative methodology for the determination of minimum farm size. 1982. D. Armer

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BUSINESS RESULTS/BEDRYFSRESULTATE

- *Production economics/ Produksie-ekonomie*

PE.5621/48/1/1: Business results and the production cost of maize, sunflower and other branches of farming in the Eastern Transvaal summer rain cropping area. 1947. D.J. Mulder

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- PE.5622/48/1/1: Management techniques: the development of an elementary book keeping book for farmers. 1982. J.M. van Zyl
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- PE.5622/48/3/4: Management techniques: farm management studies with Agrirep as data source in the Free State Region. 1982. A. de K. Marais

- PE.5622/48/4/1: Management techniques: farm management studies with mail-in records as data source in the Karoo Region. 1964. D.S. Vorster
- PE.5622/48/4/2: Management techniques: farm management studies with Agrirep as data source in the Karoo Region. 1982. D.S. Vorster
- PE.5622/48/4/3: Management techniques: farm management studies with mail-in records as data source in the Eastern Cape Region. 1964. C.J. Potgieter
- PE.5622/48/4/4: Management techniques: farm management studies with Agrirep as data source in the Eastern Cape Region. 1982. P.F. du Plessis
- PE.5622/48/5/1: Management techniques: farm management studies with mail-in records as data source in the Transvaal Region. 1964. P.J. Cornelius
- PE.5622/48/5/2: Management techniques: farm management studies with Agrirep as data source in the Transvaal Region. 1980. P.J. Cornelius
- PE.5622/48/5/3: Management techniques: farm management studies with mail-in records as data source in the Highveld Region. 1964. P.F. du Plessis
- PE.5622/48/5/4: Management techniques: farm management studies with Agrirep as data source in the Highveld Region. 1980. P.F. du Plessis
- PE.5622/48/6/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Winter Rainfall Region. 1973. C.H. Ferrandi
- PE.5622/48/8/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Karoo Region. 1973. D.S. Vorster
- PE.5622/48/8/2: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Eastern Cape Region. 1973. P.F. du Plessis
- PE.5622/48/7/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Natal Region. 1973. E.N.C. Whitehead
- PE.5622/48/7/2: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Free State Region. 1973. A. de K. Marais
- PE.5622/48/7/3: Management techniques: preparation and updating of machinery cost standards. 1980. E.N.C. Whitehead
- PE.5622/48/8/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Karoo Region. 1973. S.S. Hansen
- PE.5622/48/8/2: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Eastern Cape Region. 1973. C.J. Potgieter
- PE.5622/48/9/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Transvaal Region. 1973. D.C. du Toit
- PE.5622/48/9/2: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the summer rain cropping area of the Highveld Region. 1973. P.F. du Plessis

ENTERPRISE RELATIONSHIPS/BEDRYFSVERHOUDINGS

• *Production economics/Produksie-ekonomie*

- PE.5623/48/1/2: Enterprise relationship: economical research in respect of the control of false codling moth on citrus in the winter rain cropping area. 1981. J.M. van Zyl
- PE.5623/48/1/3: Enterprise relationship: research in respect of the difficulties in labour utilisation in Oriental tobacco production of the Western Cape in the winter rain cropping areas. 1981. J.M. van Zyl

- PE.5623/48/2/2: Enterprise relationship: the introduction of long-term pasture crops in sheep production systems in the central grassveld of the Free State Region. 1982. A. de K. Marais
- PE.5623/48/2/3: Enterprise relationship: an economic evaluation of some crop rotation systems under dryland conditions in the central Free State. 1983. R.J. Gordijn
- PE.5623/48/2/4: Enterprise relationship: an economic evaluation of some crop rotation systems under dryland conditions in the central Free State. 1983. A. de K. Marais
- PE.5623/48/2/6: Some economic aspects of fertiliser usage in maize production in Natal. 1986. C.G. Berry
- PE.5623/48/2/7: Enterprise relationship: a long-term economic evaluation of sheep production systems at different stocking rates on climax grasslands in the central Free State. 1986. A. Odendaal
- PE.5623/48/3/1: Enterprise relationship: the economic evaluation of the utilisation of fodder crops with Merino sheep in the Fish River Valley. 1982. S.S. Hansen
- PE.5623/48/3/2: Enterprise relationship: the economic evaluation of development studies of components of dry-grass bushveld grazing in the Eastern Cape. 1976. C.J. Potgieter
- PE.5623/48/3/3: Enterprise relationship: the economic evaluation of the potential of pastures in respect of small stock in the eastern coastal areas of the Eastern Cape. 1976. C.J. Potgieter
- PE.5623/48/3/4: Enterprise relationship: the development and evaluation of a profitable livestock farming system for the Valley Bushveld areas in good condition in the Eastern Cape Region. 1983. C.J. Potgieter
- PE.5623/48/3/5: Enterprise relationship: the development and evaluation of a profitable livestock farming system for the Valley Bushveld in deteriorated condition of the Eastern Cape Region. 1983. C.J. Potgieter
- PE.5623/48/3/6: Enterprise relationship: the development, management and evaluation of adapted livestock farming system Campagna in the high rainfall sourveld areas of the Eastern Cape. 1983. C.J. Potgieter
- PE.5623/48/4/1: Enterprise relationship: wintering of woolled sheep and other livestock in the northern Drakensberg grazing region. 1982. D.C. du Toit
- PE.5623/48/4/3: Enterprise relationship: the influence of different feeding strategies on the economic efficiency of beef cattle in the summer rain cropping areas. 1983. J. Hough
- PE.5623/48/4/4: Enterprise relationship: research in respect of the economic advantages of conservation tillage in the summer rain cropping area of Western Transvaal and North-western Free State. 1983. J. Hough
- PE.5623/48/4/5: An economic analysis of dairy enterprises and their financial roles in the farming structure of mixed farming in the summer rain cropping area. 1984. P.J. Cornelius
- PE.5623/48/4/6: Enterprise relationship: a comparison of margins among weaner, tollie and ox production systems in the bushveld of Northern Transvaal. 1984. D.C. du Toit
- PE.5623/48/4/7: Enterprise relationship: strategy for production continuation and renewal of citrus and subtropical orchards in the bushveld area. 1984. D.C. du Toit
- PE.5623/48/4/8: Enterprise relationship: an economic evaluation of milk and beef production of Simmentalers on natural veld and dryland - *Cenchrus* pasture on the Springbok Flats of Transvaal. 1984. P.J. Cornelius
- PE.5623/48/4/9: Enterprise relationship: the economic evaluation of the RHFA concept with respect to the minimising of risk and the determination of land values. 1986. J.J. de Bruyn
- PE.5623/48/4/10: Enterprise relationship: the influence of different feeding strategies on the economic efficiency of small stock farming in the summer rain cropping areas. 1986. P.F. du Plessis

Soil conservation/Grondbewing

EROSION/EROSIE

• *Situation analysis/Situasiebepaling*

- V.5711/35/1/1: Erosion: investigation of the functional efficiency of subsidised waterways in the middle Free State subregion. 1985. S.J. van Reenen

• *Conservation studies/Bewaringstudies*

- D.5711/38/1/1: Erosion: the determination of soil losses associated with various tillage practices on various soil series established to pineapples in the East Lodon district. 1982. C.J. Bradfield
- D.5711/38/1/2: Erosion: the determination of soil losses associated with various tillage practices and land use on soil series at Alexandria. 1983. P.C. Griffiths
- D.5711/38/2/1: Erosion: the effect of small structures in eroded watercourses in the high rainfall sourveld. 1983. B.I. Hill
- D.5711/38/2/2: Erosion: the effect of various small structures in eroded watercourses in the high rainfall sourveld. 1985. E. Marx
- D.5711/38/2/3: Erosion: the effect of small structures in eroded watercourses in the bushveld areas. 1984. G.M. Bicknell
- D.5711/38/3/1: Determining methods of re-establishing eroded, bare and hard areas with vegetation in the Tarkastad magisterial district. 1982. J.E. Aspinall
- N.5711/38/1/1: Erosion studies using natural run-off plots. 1985. R.P. Simms
- N.5711/38/1/2: Studies using a rainfall simulator and natural run-off plots to quantify soil losses from veld. 1982. R.P. Simms
- V.5711/38/1/1: Erosion: investigation of adapted grass covers for waterways in RHF 4053. 1985. P.J. Knoester
- V.5711/38/2/1: Erosion: water run-off control planning of the Immigrant area in the Petrusburg Extension Ward. 1985. F.J. Smit
- V.5711/38/2/2: Erosion: water run-off control planning of subcatchment area 3 of the Korannaberg catchment area in Excelsior district in the Brandfort Extension Ward. 1985. S.J. van Reenen
- V.5711/38/3/1: Erosion: investigation of the functional efficiency of different types of small conservation structures in eroded areas in dongas and gullies in the Edenburg Extension Ward. 1985. S. Brink
- V.5711/38/3/2: Erosion: investigation of the functional efficiency of different types of small conservation structures in dongas and gullies in the Postmasburg Extension Ward. 1985. J. Weyers

• *Engineering/Ingenieurskunde*

- LI.5711/51/1/1: Engineering aspects of soil erosion: aspects of gully erosion. 1983. P.J. Strumpher
- LI.5711/51/1/2: Engineering aspects of soil erosion: aspects regarding soil losses. 1983. P. McPhee

DRAINAGE/DREINERING

• *Agrohydrology/Agrohidrologie*

- V.5712/34/1/1: The planning and implementation of drainage systems on waterlogged and salinised irrigation lands in the Vaalharts irrigation area. 1985. J.H. Mulder

RESOURCE CONSERVATION/HULPBRONBEWARING

Planning of areas/Beplanning van gebiede

FARM PLANNING/PLAASBEPLANNING

• *Agrohydrology/Agrohidrologie*

- N.5831/34/1/1: Farm planning: run-off control planning in the Howick Extension Ward. 1979. M.G. Price
- N.5831/34/1/2: Farm planning: run-off control planning in the Greytown Extension Ward. 1979. R.C. Richardson
- N.5831/34/1/3: Farm planning: run-off control planning in the Ixopo Extension Ward. 1979. A.D. Simpson
- N.5831/34/1/4: Farm planning: run-off control planning in the Pongola Extension Ward. 1979. A.D. Robinson
- N.5831/34/1/5: Farm planning: run-off control planning in the Kokstad Extension Ward. 1979. D.B. Austin
- N.5831/34/1/6: Farm planning: run-off control planning in the Richmond Extension Ward. 1979. E.M.F. McAllister
- N.5831/34/1/7: Farm planning: run-off control planning in the Newcastle Extension Ward. 1979. M.P. Wentzel
- N.5831/34/1/8: Farm planning: run-off control planning in the Vryheid Extension Ward. 1979. R.J. Dicks
- N.5831/34/1/9: Farm planning: run-off control planning in the Estcourt Extension Ward. 1979. S.K. Armour
- N.5831/34/1/10: Farm planning: run-off control planning in the Dundee Extension Ward. 1979. P.P. Kloppers
- N.5831/34/1/11: Farm planning: run-off control planning in the Pietermaritzburg Extension Ward. 1979. P.J.D. Nicholson
- N.5831/34/1/12: Farm planning: run-off control planning in the Ladysmith Extension Ward. 1979. K.W. Watkinson

• *Management/Bestuur*

- D.5831/41/1/1: Planning of farms within the Alexandria magisterial district to promote the efficient conservation of natural resources. 1984. P.C. Griffiths
- D.5831/41/1/2: Planning of farms with regard to veld utilisation and resource conservation within the Elliot Extension Ward to promote the efficient utilisation and conservation of natural resources. 1985. E. Marx
- D.5831/41/1/3: Farm planning within the Barkly East Extension Ward to promote efficient utilisation and conservation of natural resources. 1985. J.S.J. Jordaan
- D.5831/41/1/4: Farm planning of farms within the Adelaide Extension Ward to promote efficient utilisation and conservation of natural resources. 1985. G.M. Bicknell
- D.5831/41/1/5: Planning of farms within the Bathurst magisterial district to promote the efficient utilisation and conservation of natural resources. 1985. D.L. Palmer
- D.5831/41/1/6: Planning of farms within the Tarkastad magisterial district to promote the efficient utilisation and conservation of agricultural resources. 1983. W.J.M. Els

- D.5831/41/1/7: Planning of farms in the Komga magisterial district to promote the efficient utilisation and conservation of the natural resources. 1984. C.J. Bradfield
- D.5831/41/1/8: Planning of farms in the Stutterheim Extension Ward to promote efficient utilisation and conservation of the natural resources. 1984. B.I. Hill
- D.5831/41/1/9: Planning of farms within the Sterkstroom magisterial district to promote the efficient utilisation and conservation of the natural resources. 1983. J.H. Fourie
- D.5831/41/1/10: Planning of farms within the Albany magisterial district to promote efficient utilisation and conservation of natural resources. 1986. W.J. Penny
- D.5831/41/1/11: Planning of farms with regard to veld utilisation and resource conservation within the Humansdorp Extension Ward to promote the efficient utilisation and conservation of natural resources. 1985. J.P. van Zyl
- D.5831/41/1/12: Planning of farms within the Molteno magisterial district (Dordrecht Extension Ward) to promote efficient utilisation and conservation of the natural resources. 1985. J.C. van der Walt
- D.5831/41/1/13: Planning of farms within the Uitenhage and Kirkwood magisterial districts to promote the efficient utilisation and conservation of the natural resources. 1985. C.S. van R. Müller
- D.5831/41/1/14: Planning of farms within the Queenstown magisterial district to promote the efficient utilisation and conservation of the natural resources. 1983. W.J.M. Els
- D.5831/41/1/15: Planning of farms in the Port Elizabeth magisterial district of the eastern seaboard area. 1986. R.P. Laing
- D.5831/41/1/16: Planning of farms within the Aliwal North Extension Ward to promote efficient utilisation and conservation of the natural resources. 1985. D.T. Bezuidenhout
- D.5831/41/2/1: Run-off control planning of farms in the sub-catchment area No. 10900104 in the Humansdorp Extension Ward. 1984. J.P. van Zyl
- D.5831/41/2/2: Run-off control planning of farms in the Zuney Valley, sub-catchment area No. 14200200. 1984. P.C. Griffiths
- D.5831/41/2/3: Farm planning: area run-off control planning in catchment areas No. 041308, 041309 and 041312 within the Barkly East Extension Ward. 1985. J.S.J. Jordaan
- D.5831/41/2/4: Farm planning: area run-off control planning in sub-catchment No. 17500400 in the Elliot Extension Ward. 1985. E. Marx
- D.5831/41/2/5: Run-off control planning of farms in the Baviaans River catchment area - drainage region No. 1560 - Bedford magisterial district. 1985. G.M. Bicknell
- D.5831/41/2/6: Area run-off control planning of farms in the Elands River Valley sub-catchments Nos 12100100 and 11700300. 1985. C.S. van R. Müller
- D.5831/41/2/7: Farm planning: stabilising of eroded watercourses in upper Heuningklip River - sub-catchment area 1730/02/04. 1983. J.E. Aspinall
- D.5831/41/2/8: Farm planning: run-off control planning in a portion of the sub-catchment area No. 04130500 (Bossielaagte) situated in the Lady Grey magisterial district. 1985. D.T. Bezuidenhout
- D.5831/41/2/9: Water run-off control planning of farms in the area demarcated as Upper-Coerney, sub-catchment No. 13401501 in the Paterson area. 1985. R.P. Laing
- D.5831/41/2/11: Area run-off control planning of farms in the Buyskloof Valley, sub-catchment No. 14200100, in the eastern seaboard area. 1986. P.C. Griffiths
- D.5831/41/2/12: Farm planning: maintenance and improvement of existing run-off control plans on cultivated lands in the catchment areas Nos 041308, 041309 and 041312 within the Barkly East Extension Ward. 1985. J.S.J. Jordaan
- D.5831/41/2/13: Farm planning: run-off control planning in the sub-catchment area 1543-01-01 (Vrolikskraal) situated in the Molteno magisterial district. 1985. J.C. van der Walt
- D.5831/41/2/14: Farm planning: water run-off control - improvement and maintenance contour systems in the Elands River catchment area. 1986. I.D. Barlow

- D.5831/41/2/15: Farm planning: stabilising of eroded watercourses in Bamboeshoek, sub-catchment area No 1730/02/01
- D.5831/41/2/16: Area run-off control planning of farms in the sourveld area in the Humansdorp Extension Ward of the Karoo and arid areas. 1986. E.C. Kieck
- D.5831/41/2/17: Area run-off control planning of farms in the Upper Krom River area in the Humansdorp Extension Ward of the eastern seaboard area. 1986. E.C. Kieck
- D.5831/41/2/18: Farm planning: area run-off control planning of irrigation lands in the Hankey magisterial district. 1986. R.P. Laing
- D.5831/41/2/19: Water run-off control planning of all pineapple farms in the East London Extension Ward. 1985. I.D. Scholtz

ENTREPRENEUR DEVELOPMENT ONDERNEMERSONTWIKKELING

EXTENSION SCIENCE INVESTIGATIONS VOORLIGTINGKUNDIGE ONDERSOEKE

Resources and technology/Hulpbronne en tegnologie

MANAGEMENT FACTORS/BESTUURSFAKTORE

• *Persuasion/Oorreding*

- T.6114/39/1/1: Management factors: the persuasion of farmers to optimal resource utilisation in the Lowveld area of the Transvaal Region. 1978. I.J. van Rensburg
- T.6114/39/1/2: Management factors: the persuasion of farmers to optimal resource utilisation in the Lower Crocodile and Komati River Valley. 1979. P.J. du Toit
- T.6114/39/1/3: Management factors: the persuasion of farmers to optimal resource utilisation in the extensive livestock areas of Volksrust. 1979. H.P.J. Scholtz
- T.6114/39/1/4: Management factors: the persuasion of farmers in the northern Transvaal of the Levubu irrigation area to optimal resource utilisation. 1982. S.E. Terblanche
- T.6114/39/1/5: Management factors: the persuasion of farmers to optimal resource utilisation in the Koedoesrand area of northern Transvaal in the Transvaal Region. 1976. S.W. Burger
- T.6114/39/2/3: Management factors: the persuasion of farmers to optimal resource utilisation in the Lowveld area. 1977. P.J. du Toit

MAN/MENS

• *Situation analysis/Situasiebepaling*

- H.6115/35/1/1: Factors that influence the under-achievement of first-year students at Potchefstroom College of Agriculture. 1983. L.I. de Waal

• *Persuasion/Oorreding*

- K.6115/39/1/1: Man: persuasion of putative trespassers of the Agricultural Resources Act in the Cradock Extension Ward. 1985. P.S. van Heerden
- K.6115/39/1/2: Man: persuasion of putative trespassers of the Agricultural Resources Act in the Graaff-Reinet Extension Ward. 1985. J.G. Theron
- K.6115/39/1/3: Man: persuasion of putative trespassers of the Agricultural Resources Act in the Middelburg Extension Ward. 1985. J.D. Blom

• *Extension science/Voorligtingkunde*

- D.6115/40/1/1: Man: the role of opinion leaders in the diffusion of innovations in the Stutterheim Extension Ward. 1983. P.G. King
- H.6115/40/1/1: Man: the adoption pattern of stubble mulch practices by maize farmers in the Bothaville Extension Ward. 1985. G.P. van Wyk
- H.6115/40/2/1: Man: study group participation to agricultural development in the Lichtenburg subregion. 1985. M.M. Grobbelaar
- N.6115/40/1/1: Human potential in relation to optimum land use of farmers in the Underberg Extension Ward. 1974. D.M. Rix
- T.6115/40/1/1: Man: the effective functioning of groups in agricultural development in the Northern Transvaal area. 1984. S.E. Terblanche

RUN-OFF CONTROL/AFLOOPBEHEER

• *Agrohydrology/Agrohidrologie*

- T.6118/34/1/2: Run-off control on the north-eastern Springbok Flats of the Northern Transvaal area. 1984. J. Bellingham
- T.6118/34/1/3: Run-off control in the north-eastern area of the Transvaal Region. 1976. J.C. Mouton
- T.6118/34/1/4: Run-off control in the Middle Transvaal Groot Olifants area of the Transvaal Region, area 02. 1979. K.P. de Beer
- T.6118/34/1/5: Run-off control in the Annyspruit area of the south-eastern Transvaal extension area. 1975. D.W. Nell
- T.6118/34/1/6: Run-off control in the Klein Komati area of the south-eastern Transvaal. 1975. J.C. Mouton
- T.6118/34/1/7: Run-off control in the Alma area of the Northern Transvaal area of the Transvaal Region. 1974. J. Bellingham
- T.6118/34/1/9: Run-off control in the Eerstegoud area of the Northern Transvaal area in Pietersburg. 1975. J. Bellingham
- T.6118/34/1/10: Run-off control: the design of a water run-off control system in the Bokpoort target area in Potgietersrus. 1975. J. Bellingham
- T.6118/34/1/11: Run-off control: the design of a water run-off control system for the Strydom block area - Lowveld, Komatipoort. 1975. M.V. Wattrus
- T.6118/34/1/12: Run-off control in the Sabie Valley area - the design of a water run-off control system in the Sabie Valley, Witrivier. 1975. M.V. Wattrus
- T.6118/34/2/1: Run-off control in the Badplaaskom area of the south-eastern Transvaal area of the Transvaal Region. 1975. J.C. Mouton

COMMUNICATION/KOMMUNIKASIE

• *Extension science/Voorligtingkunde*

- N.6119/40/1/1: The use of agricultural literature in communicating information to farmers in the Natal Region. 1982. Marion A. Abbott
- W.6119/40/1/1: Communication: an extension science investigation into the effectiveness of the table grape block competition in the Hex River Valley. 1985. G.C. van der Merwe

PROGRAMMED EXTENSION/GEPROGRAMMEERDE VOORLIGTING

Resource utilisation/Hulpbronbenutting

STOCK AND GAME FARMING/VEE- EN WILDBOERDERY

• *Persuasion/Oorreding*

- D.6211/39/1/1: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Queenstown Extension Ward. 1984. L.P.J. Swart
- D.6211/39/1/2: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Bedford magisterial district. 1986. J.B. Marais
- D.6211/39/1/3: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Albany magisterial district. 1986. J.L. Clacey

- D.6211/39/1/4: Stock and game farming: the persuasion of farmers to promote optimal veld utilisation and animal production in the Alexandria Extension Ward. 1986. A.E. du Plessis
- D.6211/39/1/5: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Alexandria Extension Ward. 1986. A.E. du Plessis
- D.6211/39/2/1: Stock and game farming: promotion of adapted stock farming in the Valley Bushveld of the Uitenhage Extension Ward. 1984. L.O. Grobler
- K.6211/39/1/1: Stock and game farming: persuasion of farmers to apply the group camp approach of veld management in the Extension Ward of Graaff-Reinet. 1985. J.G. Theron
- K.6211/39/1/2: Stock and game farming: persuasion of farmers to apply the group camp approach of veld management in the Cradock Extension Ward. 1985. P.S. van Heerden
- K.6211/39/1/3: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Burgersdorp Extension Ward. 1985. W. v.D. Botha
- K.6211/39/1/4: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Colesberg Extension Ward. 1985. M. van Niekerk
- K.6211/39/1/5: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the De Aar Extension Ward. 1985. W.H. van Staden
- K.6211/39/1/6: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Middelburg Extension Ward. 1985. J.D. Blom
- K.6211/39/1/7: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Calvinia Extension Ward. 1985. N. Nortje
- K.6211/39/1/8: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Carnarvon Extension Ward. 1985. G.Z.J. Barnard
- K.6211/39/1/9: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Kenhardt Extension Ward. 1985. J.J. Zandberg
- K.6211/39/1/10: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Prieska Extension Ward. 1985. D.J. Roux
- K.6211/39/1/11: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management, Beaufort West Extension Ward. 1986. A.J. Wiid
- K.6211/39/1/12: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management, Fraserburg Extension Ward. 1986. I.J. van der Merwe
- K.6211/39/2/1: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Graaff-Reinet Extension Ward. 1984. J.G. Theron
- K.6211/39/2/2: Stock and game farming: persuasion of farmers to establish drought fodder crops in the Colesberg Extension Ward. 1985. M. van Niekerk
- K.6211/39/2/3: Stock and game farming: persuasion of farmers to establish drought fodder crops in the De Aar Extension Ward. 1985. W.H. van Staden
- K.6211/39/2/4: Stock and game farming: persuasion of farmers to establish drought fodder crops in the Middelburg Extension Ward. 1985. J.D. Blom
- K.6211/39/2/5: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Calvinia Extension Ward. 1985. N. Nortje
- K.6211/39/2/6: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Carnarvon Extension Ward. 1985. G.Z.J. Barnard
- K.6211/39/2/7: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Kenhardt Extension Ward. 1985. J.J. Zandberg
- K.6211/39/2/8: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Prieska Extension Ward. 1985. D.J. Roux
- K.6211/39/2/9: Stock and game farming: persuasion of farmers to plant drought fodder crops, Beaufort West Extension Ward. 1986. A.J. Wiid
- K.6211/39/3/1: Stock and game farming: promotion of the combating of proclaimed weeds in the veld in the Somerset East Extension Ward. 1985. J.C. van Aardt

- K.6211/39/3/2: Stock and game farming: promotion of the combating of proclaimed weeds in the Graaff-Reinet Extension Ward. 1980. J.G. Theron
- N.6211/39/1/1: Stock and game farming: the promotion of cultivated pastures in the Dundee Extension Ward. 1984. B.N. Genlloud
- N.6211/39/1/2: Stock and game farming: the promotion of cultivated pastures in the Howick Extension Ward. 1981. R.N. Webster
- N.6211/39/1/3: Stock and game farming: the promotion of cultivated pastures in the Ixopo Extension Ward. 1985. M.J. Pereira da Conceico
- N.6211/39/1/4: Stock and game farming: the promotion of cultivated pastures in the Kokstad Extension Ward. 1985. G.P. Devereux
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- N.6211/41/1/1: Stock and game farming: analysis of beef production management systems in the Underberg Extension Ward. 1985. C.M. Allan
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CROP FARMING/SAAIBOERDERY

• *Persuasion/Oorreding*

- K.6212/39/1/1: Crop farming: promotion of durum wheat cultivation in the Fish River Valley in the Cradock Extension Ward. 1980. P.S. van Heerden
- K.6212/39/2/1: Crop farming: persuasion of farmers to practise optimal irrigation management and techniques in the Cradock Extension Ward. 1984. P.S. van Heerden
- K.6212/39/2/2: Crop farming: persuasion of farmers to practise optimal irrigation management and techniques in the Somerset East Extension Ward. 1984. P.S. van Heerden

- N.6212/39/1/1: The promotion of improved crop farming practices in the Winterton conservation area. 1976. S.D. le Roux
- W.6212/39/1/1: Crop farming: the persuasion of farmers in the George Extension Ward to implement improved sowing techniques. 1985. W.G.J. Voigt
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MIXED FARMING/GEMENGDE BOERDERY

• *Persuasion/Oorreding*

- D.6213/39/1/1: Mixed farming: to persuade crop farmers in the Alexandria Extension Ward to adopt optimal crop production systems. 1986. A.E. du Plessis
- H.6213/39/1/1: Persuasion of farmers with mixed farming enterprises in the Bethlehem Extension Ward in order to promote optimal land utilisation. 1981. J.H. de Klerk
- H.6213/39/1/2: Persuasion of farmers with mixed farming enterprises in the Harrismith Extension Ward in order to promote optimal land utilisation. 1983. J.T. van Rooyen
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- H.6213/39/1/5: Persuasion of farmers with mixed farming enterprises in the Parys Extension Ward in order to promote optimal land utilisation. 1981. A.G.H. Kotzé
- H.6213/39/1/6: Persuasion of farmers with mixed farming enterprises in the Klerksdorp Extension Ward in order to promote optimal land utilisation. 1981. C.F. van Eeden
- H.6213/39/1/7: Persuasion of farmers with mixed farming enterprises in the Lichtenburg subregion in order to promote optimal land utilisation. 1982. M.M. Grobbelaar
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- H.6213/39/1/9: Persuasion of farmers with mixed farming enterprises in the Wolmaransstad Extension Ward in order to promote optimal land utilisation. 1986. A.J. Loretz
- H.6213/39/1/10: Persuasion of farmers with mixed farming enterprises in the Potchefstroom Extension Ward in order to promote optimal land utilisation. 1986. J.J. Steyn
- T.6213/39/1/1: Mixed farming: the persuasion of farmers to practise optimal resource utilisation in the high rainfall sourveld area of Belfast. 1985. A. van Deventer
- V.6213/39/1/1: Mixed farming: the persuasion of stock farmers in the Mafeking Extension Ward to contain bush encroachment. 1985. W. Goldblatt
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FRUIT FARMING/VRUGTEBOERDERY

• Situation analysis/Situasiebepaling

- N.6214/35/1/1: **Situation analysis: bananas in the Port Shepstone Extension Ward. 1983. E.H. Gevers**

• Persuasion/Oorreding

- T.6214/39/1/1: **Fruit farming: the persuasion of guava farmers to optimal resource utilisation in the irrigation areas of the Lowveld. 1982. J.J. Kruger**
- T.6214/39/1/2: **The persuasion of banana producers to optimal resource utilisation in the irrigation areas of the Transvaal Lowveld. 1983. C.C. Engelbrecht**
- W.6214/39/1/1: **Fruit farming: persuasion of farmers in the Langkloof farming area to implement recommended soil-plant combinations, correct soil preparation and established techniques. 1985. W.S. van der Merwe**
- W.6214/39/2/1: **Fruit farming: persuasion of farmers in the Ceres Extension Ward to apply effective control of codling moth on pome fruit. 1985. P.W. Immelman**

VITICULTURE/WINGERDBOERDERY

• Persuasion/Oorreding

- W.6216/39/1/1: **Viticulture: persuasion of farmers in the Vredendal Extension Ward to apply correct techniques of winter pruning and manipulation of summer foilage. 1985. P.B. van der Merwe**
- W.6216/39/2/1: **Viticulture: persuasion of farmers in the Amalienstein/Van Zylsdamme farming area to implement optimal irrigation techniques. 1985. M.J. de W. Delpont**
- W.6216/39/3/1: **Viticulture: persuasion of farmers in the Mamalienstein/Van Zylsdamme farming area to implement recommended soil-plant combinations, correct soil preparation and establishment techniques for perennial crops. 1985. M.J. de W. Delpont**
- W.6216/39/3/2: **Viticulture: persuasion of farmers in the irrigation areas of Montagu Extension Ward to implement recommended soil-crop combinations, correct soil preparation and establishment techniques for perennial crops. 1985. W.J. Basson**
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AGRICULTURAL ENGINEERING SERVICES LANDBOU-INGENIEURSDIENSTE

Agricultural mechanisation/Landboumeganisasie

POWER SOURCES AND LABOUR/KRAGBRONNE EN ARBEID

• Engineering/Ingenieurskunde

- LI.6711/51/1/1: **Evaluation of tractor characteristics - power take-off shaft and safety frames. 1982. J.J.P.C. Swanepoel**

- LI.6711/51/1/2: Power sources and labour: performance of two-wheel, four-wheel and crawler track-driven tractors under a variety of conditions. 1981. R.W. Otterman
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AGRICULTURAL IMPLEMENTS/LANDBOUWERKTUIG

- *Engineering/Ingenieurskunde*

- LI.6712/51/1/1: Engineering aspects of agricultural machinery. 1982. A.J. Heyns

Agricultural structures and facilities/Landboustructuur en -fasiliteite

CLIMATE-CONTROLLED STRUCTURES/KLIMAATBEHEERDE STRUKTURE

- *Engineering/Ingenieurskunde*

- LI.6722/51/1/1: Engineering aspects of climatic-controlled structures. 1982. P.J. Britz

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- *Engineering/Ingenieurskunde*

- LI.6723/51/1/1: Engineering aspects of animal housing and facilities. 1982. P.A. Henning
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Irrigation and drainage engineering/Besproeiings- en dreineringsingenieurswese

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- *Engineering/Ingenieurskunde*

- LI.6731/51/1/1: Engineering aspects of irrigation. 1982. F.B. Reinders

DRAINAGE/DREINERING

- *Engineering/Ingenieurskunde*

- LI.6732/51/1/1: Engineering aspects of sub-surface drainage systems. 1982. F.J.C. Hugo

BOTANY/BOTANIE

BOTANY RESEARCH/BOTANIESE NAVORSING

Plant taxa/Planttaksons

FLORA

• Taxonomy/Taksonomie

- PL.7111/01/1/6: Flora of southern Africa: Liliaceae - Dracaenoideae and Asparagoideae. 1979. G.E. Gibbs Russell
- PL.7111/01/1/7: Flora of southern Africa: Ericaceae - minor genera. 1970. E.G.H. Oliver
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- PL.7111/01/1/17: Flora of southern Africa: keys to southern African grasses. 1981. G.E. Gibbs Russell
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- PL.7111/01/1/23: Flora of southern Africa: Salicaceae, Fabaceae, Urticaceae and Piperaceae. 1984. K.L. Immelman
- PL.7111/01/1/24: Flora of southern Africa: the tribe Tephrosieae (Fabaceae - Papillonoideae). 1985. B.D. Schrire
- PL.7111/01/1/25: Flora of southern Africa: the genus *Rhus* (Anacardiaceae). 1985. R.O. Moffett
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- PL.7112/01/1/1: Taxonomy of Angiospermae: the family Polygonaceae. 1979. T.H. Arnold
- PL.7112/01/1/3: Taxonomy of Angiospermae: the genus *Ficinia* (section Bracteosae). 1976. G. Germishuizen
- PL.7112/01/1/5: Taxonomy of Angiospermae: the genus *Justicia* in southern Africa. 1982. K.L. Immelman
- PL.7112/01/1/7: Taxonomy of Angiospermae: the genus *Vigna* Savi in southern Africa. 1984. B.J. Pienaar

- PL.7112/01/1/8: Taxonomy of Angiospermae: the genus *Carex* L. in southern Africa. 1985. C. Reid
- PL.7112/01/1/9: Taxonomy of Angiospermae: the broad-leaved species of the genus *Asclepias* L. in southern Africa. 1986. A. Nicholas
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- PL.7112/02/1/1: Comparative anatomy of the angiosperm subfamily Arundinoideae. 1972. R.P. Ellis
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- PL.7112/02/1/8: Development of a leaf-tensilemeter for measuring fibre-related leaf tensile strength and application thereof for determining palatability of grasses (Angiospermae). 1986. R.H. Westfall
- PL.7112/02/2/1: Morphological and anatomical survey of the wood and bark of southern African woody Angiospermae. 1984. P.P.J. Herman
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- PL.7112/06/1/1: Cytotaxonomic studies of Angiospermae: the genus *Sorghum*. 1983. J.J. Spies
- PL.7112/06/2/1: Karyotype studies of the Angiosperm family Poaceae: the subfamily Arundinoideae. 1983. J.J. Spies
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• *Plant geography/Plantgeografie*

- PL.7112/25/1/3: Final distribution atlas of the woody Angiospermae of the Transvaal. 1979. J.M. Anderson

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• *Taxonomy/Taksonomie*

- PL.7115/01/1/1: Bryophyta: the ultrastructure of the wall ornamentation as a taxonomic aid in identifying the species of the genus *Riccia* (Hepaticae) in southern Africa. 1981. S.M. Perold

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- PL.7118/01/1/1: The fossil plants of the Upper Triassic Molteno Formation in South Africa. 1978. J.M. Anderson

Vegetation/Plantegroei

FOREST/WOUD

- *Ecology/Ekologie*

- PL.7121/27/1/1: Vegetation study of the Zululand coastal dunes, including forest, between Richards Bay and Mlalazi Lagoon. 1980. P.J. Weisser
- PL.7121/27/1/2: Coast forest biome: conservation priorities in the dune area between Kosi Bay and Sodwana based on a vegetation survey. 1985. P.J. Weisser
- PL.7121/27/2/1: A regional plant-ecological study of forests, woodlands and grasslands of the north-eastern mountain sourveld (and adjacent lowveld sour bushveld) in the Sabie area of the Eastern Transvaal escarpment. 1982. G.B. Deall

BUŠVELD/BOSVELD

- *Ecology/Ekologie*

- PL.7122/27/1/1: Seasonal growth of woody bushveld plants in the Nylsvley *Burkea* Savanna Ecosystem Project. 1975. M.C. Rutherford
- PL.7122/27/2/1: The plant ecology of the bushveld farm Groothoek, Thabazimbi district. 1980. R.H. Westfall
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- *Ecology/Ekologie*

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- PL.7123/27/1/2: A semi-detailed regional ecological study of the Western Cape lowland fynbos. 1970. J.C. Scheepers
- PL.7123/27/1/3: A plant-ecological study of the fynbos and other vegetation in the southern Cape coastal foreland. 1985. J.C. Scheepers
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GRASSLAND/GRASVELD

- *Ecology/Ekologie*

- PL.7124/27/1/1: A plant-ecological study of the grassland and other vegetation in the Amersfoort area of Eastern Transvaal highveld. 1984. B.J. Turner
- PL.7124/27/1/2: A plant-ecological study of the grassland and other vegetation in the Grootvlei area of the Highveld Region. 1984. C.J. Scheepers

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